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DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

BULLETIN 480

MINERAL RESOURCES OF ALASKA

REPORT ON PROGRESS OF INVESTIGATIONS IN

1910

BY

ALFRED H. BROOKS AND OTHERS

WASHINGTON
GOVERNMENT PRINTING OFFICE
1911

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INVESTIGATION OF THE MINERAL RESOURCES OF ALASKA IN 1910.

By ALFRED H. BROOKS and others.

ADMINISTRATIVE REPORT.

By ALFRED H. BROOKS.

PREFACE.

This volume is the seventh[1] of the series issued annually by the Geological Survey, each of which summarizes for the year both the conditions of the mining industry and the most important results obtained by the investigations of the mineral wealth. The purpose of these reports is to furnish a convenient handbook for those interested in the mining industry of Alaska and to make available the more important economic results of the year's surveys in advance of the publication of complete reports, which usually require at least six months for office preparation by the author and then, because each must await its turn, from two or three months to a year for publication. In a region like Alaska, where developments are going on rapidly, such a delay after the completion of the field work may seriously impair the value of the publication to the prospector. On the other hand, the publication of the advance statements in these progress reports implies hasty preparation and in some cases the presentation of conclusions which may be changed by the more exhaustive office study. Therefore those interested in any particular district are urged to procure a copy of the more complete report as soon as it is issued.

The same arrangement will be maintained in this volume as in those previously issued. First will be presented papers of a general character, followed by those referring to special districts, which will be arranged geographically from south to north. This bulletin contains 15 papers by 11 authors, of which 2 deal with administrative

[1] Report on progress of investigation of the mineral resources of Alaska, 1904: Bull. U. S. Geol. Survey No. 259, 1905; Idem, 1905: Bull. 284, 1906; Idem, 1906: Bull. 314, 1907; Idem, 1907: Bull. 345, 1908; Idem, 1908: Bull. 379, 1909; Idem, 1909: Bull. 442, 1910.

matters, 3 are summaries of some features of the mining industry, and the remainder deal more specifically with problems of economic geology.

In the preparation of the summaries of the mining industries the writer, as in previous years, has in part been dependent on information gleaned from various sources, for it is impossible with the small force available to have a representative of the Survey visit each of the many Alaska mining districts. These summaries could not be prepared were it not for the cordial cooperation of the residents of the Territory, including mine operators, Federal officials, officers of banks and of transportation and commercial companies, mining engineers, and many prospectors. It would be impossible to enumerate all those who have contributed information, but special acknowledgment should be made to the following: The Director of the Mint; S. Irvine Stone, of Kodiak; Melvin Dempsey, of Dempsey; H. S. Ferris and H. P. Gallagher, of Susitna; W. M. Harrison, of Cache Creek; E. R. Stivers, of Fortymile; J. J. Hillard, of Eagle; Ralph Donaldson, of Rampart; Benjamin F. Baker and Joseph H. Eglar, of Tofty; William A. Fitzpatrick, of Chena; D. H. Boyer, Alaska Pacific Express Co., First National Bank, and Washington, Alaska & Fairbanks Banking Co., of Fairbanks; F. J. Marsh, of Caro; John A. Dexter, of Chenik; C. W. Thornton, of Solomon; and J. W. J. Reed, of Nome.

During the season of 1910, 12 parties were engaged in Alaskan surveys for varying lengths of time between April 1 and October 17. In addition to these the geologist in charge did some field work. The personnel of these parties included 12 geologists, 4 topographers, 2 engineers, and 27 packers, cooks, etc. In addition to these some gage readers were employed who gave only part of their time to the work. Four of the parties were engaged in geologic work, two in both geologic and topographic surveys, four in topographic surveys, and two in investigating water resources.

The areas covered by geologic reconnaissance surveys, on a scale of 1 : 250,000 (4 miles to the inch), amount to 8,635 square miles; by detailed geologic surveys, on a scale of 1 : 62,500 (1 mile to the inch), 321 square miles. Much of the time of the geologists was devoted to the investigation of special field problems in the important mining districts, the results of which can not be presented areally. Some 13,815 square miles of topographic reconnaissance surveys, on a scale of 1 : 250,000 (4 miles to the inch), and 36 square miles of detailed topographic surveys, on a scale of 1 : 62,500 (1 mile to the inch), were completed.

In 1910, 54 gaging stations were maintained in the Yukon-Tanana region for an average of 143 weeks each, furnishing data on the water resources of about 4,700 square miles. Fifteen gaging stations

were also maintained for 170 weeks in Seward Peninsula, yielding data on the run-off of some 1,800 square miles.

To state the work geographically, two parties were in southeastern Alaska, three in the Copper River and Susitna basins, one in the Matanuska Valley, three in the upper Yukon basin, two in the Innoko-Iditarod region, and one in the Kobuk region.

Among the important results of the year were the completion of the detailed survey of that part of the Juneau gold belt which lies between Salmon Creek and Berners Bay and of the part of the Matanuska coal field lying west of Chickaloon River and the completion of the geologic and topographic reconnaissance mapping of the Bonnifield district, the Valdez Creek region, and the most important part of the Innoko and Iditarod region. The accumulation of data on the water resources of the Yukon-Tanana region and of Seward Peninsula is yielding results of importance to the placer-mining industry.

The following table shows the allotment, including both field and office expenses, of the total appropriation of $90,000 to the districts investigated:

Allotment to Alaskan surveys and investigations in 1910.

Southeastern Alaska	$5,100
Copper River region	27,000
Matanuska region	9,600
Upper Yukon basin	23,800
Innoko-Iditarod region	14,100
Northwestern Alaska, including Seward Peninsula	10,400
	90,000

In the following table the approximate amount of money devoted to each class of investigations and surveys is indicated. It is not possible always to give the exact figures, as in some cases the same party or even the same man has carried on two different kinds of work, but this statement will help to elucidate a later table which will summarize the complete areal surveys.

Approximate allotments to different kinds of surveys and investigations in 1910.

Geologic reconnaissance surveys	$26,500
Detailed geologic surveys	11,500
Special geologic investigations	2,500
Topographic reconnaissance surveys	32,000
Detailed topographic surveys	1,600
Investigation of water resources	4,600
Collection of statistics of mineral production	1,100
Miscellaneous, including clerical salaries, administration, inspection, instruments, office supplies, and equipment	10,200
	90,000

Allotments for salaries and field expenses, 1910.

Scientific and technical salaries	$29,330
Field expenses	51,765
Clerical and other office salaries	8,905
	90,000

The following table exhibits the progress of the Alaskan investigations and the annual grant of funds since systematic surveys were begun in 1898. It should be noted that a varying amount is expended each year on special investigations, yielding results which can not be expressed areally.

Progress of surveys in Alaska, 1898–1910.[a]

Year.	Appropriation.	Areas covered by geologic surveys.			Areas covered by topographic surveys.[b]					Water resources investigations.	
		Exploratory (scale 1:625,000 or 1:1,000,000).	Reconnaissance (scale 1:250,000).	Detailed (scale 1:62,500).	Exploratory (scale 1:625,000 or 1:1,000,000).	Reconnaissance (scale 1:250,000; 200-foot contours).	Detailed (scale 1:62,500; 25, 50, or 100 foot contours).	Lines of levels.	Bench marks set.	Gaging stations maintained part of year.	Stream-volume measurements.
		Sq. m.	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Miles.*			
1898	$46,189.60	9,500	.....	.....	12,840	2,070	.....	.....	.....	.....	.....
1899	25,000.00	6,000	.....	.....	8,690	.....	.....	.....	.....	.....	.....
1900	60,000.00	3,300	6,700	.....	630	11,150	.....	.....	.....	.....	.....
1901	60,000.00	6,200	5,800	.....	10,200	5,450	.....	.....	.....	.....	.....
1902	60,000.00	6,950	10,050	.....	8,330	11,970	96	.....	.....	.....	.....
1903	60,000.00	5,000	8,000	96	.....	15,000	.....	.....	.....	.....	.....
1904	60,000.00	4,050	3,500	.....	800	6,480	480	86	19	.....	.....
1905	80,000.00	4,000	4,100	536	.....	4,880	787	202	28	.....	.....
1906	80,000.00	5,000	4,000	421	.....	13,500	40	.....	.....	14	286
1907	80,000.00	2,600	1,400	442	.....	6,120	501	95	16	48	457
1908	80,000.00	2,000	2,850	604	.....	3,980	427	76	9	53	556
1909	90,000.00	6,100	5,500	450	6,190	5,170	444	.....	.....	81	703
1910	90,000.00	.....	8,635	321	.....	13,815	36	.....	.....	69	429
	871,189.60	60,700	60,535	2,870	47,680	99,585	2,811	459	72	.....	.....
Percentage of total area of Alaska		10.35	10.32	0.49	8.16	16.98	0.48	.....	.....	.....	.....

[a] The areas presented in this table differ somewhat from those published previously to 1909. This is due in part to the reclassification of the work and in part to the fact that the areas have been more carefully scaled from the maps than formerly.

[b] In addition to the above the International Boundary Survey and the Coast and Geodetic Survey have made surveys of parts of Alaska.

GEOGRAPHIC DISTRIBUTION OF INVESTIGATIONS.

GENERAL WORK.

The writer was engaged in office work at Washington until August 3, when he proceeded to Alaska, reaching Valdez on August 15. A day was spent in visiting the Cliff mine, and the journey was continued to Seward and then to Knik, two days being spent en route in studying the geology in the vicinity of Kern Creek. From Knik

the writer proceeded to Mr. Martin's camp, which was reached on August 23. The following two weeks were spent in studying the geology of the Matanuska coal field, and then the writer returned to Seward. A day at Knik and several days at Seward were utilized in collecting data to be used for planning subdivisional surveys in this general region. (See pp. 15–20.) Returning, the writer reached Washington on September 30.

Of the time spent in the office the geologist in charge has devoted about 30 days to the completion of the Mount McKinley report (Professional Paper 70), about 50 days to the progress report, 15 days to subdivisional surveys (see pp. 15–20), and the rest to routine and miscellaneous matters.

R. H. Sargent continued the general supervision of the topographic surveys and map compilation, as in the previous year, but since July 1 his time has been largely devoted to the subdivisional surveys of Alaska public lands.

E. M. Aten continued as office assistant to the geologist in charge and supervised the office work during the writer's absence in the field. He also continued to assist in the collection of statistics of production of precious metals in Alaska.

The office study of the problems relating to the stratigraphy of Alaskan Tertiary coal measures was continued by W. W. Atwood during such time as he could spare from his college work. As the correlating of the coal measures of different parts of the Territory depends on the determination of their fossil plants, Arthur Hollick was employed for a part of the year on a systematic study of the large amount of paleobotanic material already collected.

SOUTHEASTERN ALASKA.

Adolph Knopf was employed from June 3 to September 7 in completing the detailed geologic mapping and study of the mineral resources of the Eagle River region. In this time he covered an area of 125 square miles. He then devoted 11 days to studying special mining problems near Juneau, 5 days to the Sitka mining district, and 11 days to collecting data on the mining developments in other parts of southeastern Alaska. (See pp. 94–110.)

J. W. Bagley, assisted by C. E. Giffin, spent the time from May 6 to June 6 in detailed topographic mapping of an area of 36 square miles in the vicinity of Mendenhall River, thus completing the surveying of the Eagle River district.

C. W. Wright was employed from July 6 to September 17 in continuing the work of preparing a report on the geology and mineral resources of Kasaan Peninsula and Hetta Inlet region. Unfortunately, he was called back to his professional work in Sardinia before he could complete his report, but he has promised an early completion.

COPPER RIVER AND SUSITNA REGION.

D. C. Witherspoon and C. E. Giffin began a topographic reconnaissance survey in the upper Chistochina region on July 1 and carried it westward into the Susitna basin, including the Valdez Creek placer district. The party was divided into two sections and continued work until September 12, covering an area of 4,980 square miles.

F. H. Moffit, assisted by B. L. Johnson, made a geologic reconnaissance survey of the southern front of the Alaska Range between the Fairbanks trail and Valdez Creek. He also made a reexamination of the Chistochina placer district, which had previously been mapped by W. C. Mendenhall. The Moffit party began work July 8 and continued until September 3. A geologic reconnaissance map of about 1,000 square miles was completed, in addition to which the topographic surveys and geologic notes furnished by the Witherspoon party furnished a general knowledge of the areal distribution of the principal formations over some 2,000 square miles. A preliminary statement of Mr. Moffit's results is presented on pages 112–126.

PRINCE WILLIAM SOUND AND KENAI PENINSULA.

No field work was done in the Prince William Sound and Kenai Peninsula regions other than that accomplished by the geologist in charge (p. 8). U. S. Grant has continued, so far as his collegiate duties permitted, the work of writing a report on the eastern part of the Kenai Peninsula.

MATANUSKA VALLEY.

G. C. Martin, assisted by F. J. Katz and Theodore Chapin, made a detailed geologic survey of that part of the Matanuska coal field lying between Moose Creek on the west and Chickaloon River on the east. An area of 196 square miles was surveyed during the period extending from June 3 to September 8. (See pp. 128–138.) At the close of the season Mr. Katz, assisted by Mr. Chapin, spent about a week in studying the mineral resources of the Willow Creek region. (See pp. 139–151.)

UPPER YUKON BASIN.

No geologic field work was done in the Yukon-Tanana region, but L. M. Prindle spent nine months of the year in preparing a detailed report on the region adjacent to Fairbanks and a more general report on the Fairbanks quadrangle. C. E. Ellsworth and G. L. Parker continued the study of the water resources of the Yukon-Tanana region which was begun in 1907. They began field work at Fairbanks on April 1 and then extended it into the Birch Creek district. Mr. Parker continued stream gaging in the Fairbanks

and Birch Creek districts until September 1, when he went to Nome (p. 12). After organizing the work in these two districts, Mr. Ellsworth went to Eagle, which he reached on June 11, and began a systematic study of the water supply of the Fortymile region. This work was continued until September 19. A summary of the results of these investigations is presented on pages 173–217 of this volume.

J. W. Bagley, topographer, and S. R. Capps, geologist, carried a topographic and geologic reconnaissance survey from the upper Nenana Valley eastward to Delta River. The area surveyed includes 3,135 square miles and is bounded on the south by the crest of the Alaska Range and on the north by the lowlands of the Tanana Valley. These surveys were begun on June 26 and completed on September 13. The area surveyed includes the Bonnifield placer district and the larger part of the Nenana coal field. (See pp. 218–235.)

INNOKO-IDITAROD REGION.

The continued interest in the placer-gold deposits of the Innoko basin, including the newly discovered Iditarod placers, led to extending the work previously done in this field. G. C. Anderson made a topographic reconnaissance survey of an area of 3,200 square miles, extending southward from Ruby Creek, on the Yukon, across the upper Innoko Valley, and including much of the Iditarod basin. A. G. Maddren, assisted by H. E. Birkner, made a geologic reconnaissance survey of about 2,000 square miles of the most important part of the same region, besides investigating the placers of the Innoko and Iditarod districts. (See pp. 236–270.) The work was begun on June 19 and continued until September 16.

NORTHWESTERN ALASKA.

P. S. Smith and H. M. Eakin carried a geologic and topographic reconnaissance survey from the Koyukuk to Kobuk River. The party landed near the mouth of Hogatza River on June 22 and traveled overland to Dahl Creek, on the Kobuk. (See pp. 271–305.) A contract had been made to have supplies delivered at this point, but an accident had prevented delivery and the party was therefore forced to abandon the original plan of extending the survey southwest to Seward Peninsula and made its way down the Kobuk by small boat. This, however, gave opportunity to pay a hasty visit to the newly discovered Squirrel River placer district (see pp. 306–319), where the field work was ended on August 21. In spite of the season's work being curtailed by loss of supplies, an area of 2,500 square miles was covered by geologic and topographic reconnaissance surveys.

Systematic investigations of the water supply of Seward Peninsula have been carried on each year since 1906. The need of investigations

in other parts of Alaska made it impossible to detail an engineer to continue this work in 1910. Through the cooperation of a number of mine operators it has been possible to keep up some gaging stations during the open season of 1910. In addition to the data thus obtained, G. L. Parker spent from September 15 to October 18 in Seward Peninsula in collecting the gage readings furnished by individuals and in making stream measurements. All these data are now being used in the preparation of a summary report on the water resources of Seward Peninsula.

COLLECTION OF STATISTICS.

As in previous years, the statistics of the gold, silver, and copper production of Alaska were collected by the writer, assisted by members of the field force and by Mr. Aten. Every year a larger percentage of the operators show their interest in this work by furnishing data of production. There are, unfortunately, still a rather large number of placer-mine operators who neglect to make returns of production, though the schedules are mailed to them each year. Such action, by decreasing the accuracy of the published totals for each district, injures the mining industry. It is believed that a large part of those who fail to report their production ignore the request sent by schedule because of the rush of work during the short open mining season. There may be some, however, who dislike to reveal their gold production, even to the Geological Survey. Those operators who have hesitated to furnish the desired information for fear it might be used to their disadvantage are reminded of the fact that the Geological Survey has received confidential information from practically every mining corporation in the States for many years and has never been charged with betraying a confidence. The figures furnished are used only to make up totals of districts, and every precaution is taken to prevent their being published in any way to indicate the output of individuals or corporations unless permission has been explicitly granted in writing.

The attention of all those interested in the advancement of the mining industry of Alaska is directed to the fact that it will be greatly to the advantage of this industry if accurate figures of the gold output of each district are published. If funds were available for sending a representative into each district to collect the required information in person, complete and reliable figures could undoubtedly be had. As it is, the work is still largely done by correspondence, and the address list of operators is by no means complete. It is expected, however, that soon every operator in the Territory will report his production, so that accurate totals for each district can be published. Until this is done the figures of production can be only approximate. Fortunately, there are other though less exact sources of information.

The statement of placer-gold production as presented is, then, based in part on the returns from operators and in part on data furnished by bankers, express companies, Federal officials, and other residents of Alaska.

PUBLICATIONS ISSUED OR IN PREPARATION.

During 1910 the Survey published five bulletins relating to Alaska. Three bulletins, one professional paper, and two maps are in press. The authors' work on two other reports, to appear as bulletins, has been completed, and illustrations for these are being prepared. The office work on eight other reports is sufficiently advanced to make it reasonably certain that they will be ready to submit for publication on or before the 1st of July, 1911. Six other reports will probably be submitted during the year 1911. The reports in press or in preparation include 14 new topographic maps, to be published on scales of 1:500,000, 1:250,000, or 1:62,500.

REPORTS ISSUED.

The Innoko gold-placer district, Alaska, with accounts of the central Kuskokwim Valley and the Ruby Creek and Gold Hill placers, by A. G. Maddren. Bulletin 410.

Mineral resources of the Nabesna-White River district, Alaska, by F. H. Moffit and Adolph Knopf; with a section on the Quaternary, by S. R. Capps. Bulletin 417.

Geology and mineral resources of the Solomon and Casadepaga quadrangles, Seward Peninsula, Alaska, by Philip S. Smith. Bulletin 433.

Mineral resources of Alaska in 1909, by A. H. Brooks and others. Bulletin 442.

Reconnaissance of the geology and mineral resources of Prince William Sound, Alaska, by U. S. Grant and D. F. Higgins. Bulletin 443.

REPORTS IN PRESS.

The Mount McKinley region, Alaska, by A. H. Brooks; with descriptions of the igneous rocks and of the Bonnifield and Kantishna districts, by L. M. Prindle. Professional Paper 70.

Geology and mineral resources of the Berners Bay region, by Adolph Knopf. Bulletin 446. [Issued February 16, 1911.]

Geology and mineral resources of the Nizina region, Alaska, by F. H. Moffit and S. R. Capps. Bulletin 448.

Geologic reconnaissance in southeastern Seward Peninsula and Norton Bay-Nulato region, Alaska, by P. S. Smith and H. M. Eakin. Bulletin 449. [Issued June 17, 1911.]

REPORTS IN PREPARATION.

The Yakutat Bay earthquake of September, 1899, by R. S. Tarr and Lawrence Martin. Professional Paper 69.

Geology and mineral resources of parts of the Alaska Peninsula, by W. W. Atwood; including geologic and topographic reconnaissance maps. Bulletin 467.

Geologic reconnaissance of the Iliamna region, Alaska, by G. C. Martin and F. J. Katz, including geologic and topographic reconnaissance maps. Bulletin 485.

Geology and ore deposits of Kasaan Peninsula and the Copper Mountain region, Prince of Wales Island, by C. W. Wright; including detailed geologic and topographic maps.

Geology of Glacier Bay and Lituya region, by F. E. Wright and C. W. Wright, including geologic reconnaissance maps.

Geology and mineral resources of the Eagle River region, by Adolph Knopf; including detailed geologic and topographic maps.

Preliminary report on mineral deposits of Sitka region, by Adolph Knopf.

The headwater region of the Gulkana and Susitna rivers, with an account of the Chistochina and Valdez Creek placers, by F. H. Moffit, including geologic and topographic reconnaissance maps.

Geology and mineral resources of the southern part of Kenai Peninsula, by U. S. Grant and D. F. Higgins, including geologic reconnaissance maps.

The coal fields of the lower Matanuska Valley, by G. C. Martin.

Geology and mineral resources of the Fairbanks district, by L. M. Prindle and F. J. Katz; including detailed topographic and geologic maps.

The Fairbanks quadrangle, by L. M. Prindle; including geologic and topographic reconnaissance maps.

The Bonnifield region of the Tanana Valley, by S. R. Capps; including geologic and topographic reconnaissance maps.

The Koyukuk-Chandalar gold region, by A. G. Maddren; including geologic and topographic reconnaissance maps.

The Iditarod-Innoko region, by A. G. Maddren; including geologic and topographic reconnaissance maps.

Geology of the Nome and Grand Central quadrangles, by F. H. Moffit and Philip S. Smith; including detailed geologic map.

The water supply of Seward Peninsula, by F. F. Henshaw and P. S. Smith; including topographic reconnaissance map.

REPORT ON PROGRESS OF SURVEYS OF PUBLIC LANDS IN ALASKA DURING 1910.

By ALFRED H. BROOKS.

INTRODUCTION.

An item in the sundry civil act approved June 25, 1910, provided "for the survey of the lands in the United States in the District of Alaska, $100,000." In accordance with instructions, the Director of the Geological Survey, on June 25, 1910, submitted plans for the surveys authorized by this item to the Secretary through the Commissioner of the General Land Office. These were approved by the Commissioner and by the Secretary on June 29. In a letter dated June 29 the Director instructed the geologist in charge of the division of Alaskan mineral resources to put the plans into execution.

OUTLINE OF PLANS.

The approved plans authorized the following surveys:

1. The astronomic determination of the latitude, longitude, and azimuth in the vicinity of the initial point of the proposed surveys near Fairbanks.
2. Time permitting, the astronomic determination of latitude, longitude, and azimuth at another point near the mouth of Tanana River which might be used as a reference point for future land surveys in this district.
3. The inauguration of a triangulation system in the vicinity of Fairbanks by which the accurate location of land lines and corners could be determined and which could also be developed so as to permit extensions into other areas where subdivisional surveys are needed.
4. The extension of a base and meridian from the initial point near Fairbanks.
5. The surveying of such township exteriors as were deemed advisable.
6. Time permitting, the subdivision of these townships.
7. The making of reconnaissances in the Copper River, Seward, and Matanuska regions for the sake of obtaining information on which to plan surveys in these provinces.

METHODS OF SURVEY.

The surveys provided for three classes of work—astronomic determination of positions, triangulation, and linear measurement.

The astronomic work was performed by the Coast and Geodetic Survey in accordance with its long-established standards and methods.

The triangulation, including measurement of base, was executed in accordance with the standards and methods of the Geological Survey.

The approved plans authorized the making of linear measurements either by stadia or with steel tape, depending on the physical character of the country to be surveyed. In either method the standard set for accuracy was to be maintained. In practice it was found that the lines actually run could be best measured by steel tape. There is no doubt, however, that under favorable conditions the stadia is applicable and advisable.

The plans approved also provided that the township corners should be tied to triangulation points so far as practical, thus giving an entirely independent check on the line work. It is worthy of note that this is the first time that any subdivisional surveys made by the United States Government have been checked by triangulation. The United States is the only country in the world which does not use geodetic methods in making its land surveys.

Soon after reaching the field the engineers satisfied themselves that in this latitude and under existing climatic conditions the old method of controlling the azimuth of linear surveys by means of solar transit was not practical for the following reasons:

1. Observations on Polaris through the small telescopes of the transits are impracticable before the 10th of August.

2. The altitude of Polaris, about 65° in this latitude, increases the difficulty of accurate observations.

3. The sun's path in this high latitude is such that solar observations for a good part of the day are very unreliable.

4. During the season of 1910, owing to climatic conditions, the sun was visible for solar observations only about one-fifth of the time.

Accordingly the lines were run as plain transit lines on the basis of the azimuth determination made at the astronomic station and transferred to the different lines by the triangulation system. This not only saved time but yielded results of a higher degree of accuracy than could be obtained in this latitude by the old method.

PERSONNEL.

As provided for in the plans submitted, the Superintendent of the Coast and Geodetic Survey detailed the necessary engineers to make the latitude, longitude, and azimuth determinations at Fairbanks and at the mouth of the Tanana.

R. H. Sargent, topographer, was put in charge of the field parties at Fairbanks. C. L. Nelson, W. N. Vance, and S. G. Lunde, topographers, were detailed to assist Mr. Sargent. In addition to these four engineers, who were detailed from the permanent staff of the Geological Survey, four chainmen and one recorder accompanied the party from Seattle. At Fairbanks 21 other men were engaged as rodmen, axmen, packers, cooks, etc.

The personnel of the two line parties and the triangulation party were as follows:

Line parties:
- 1 engineer in charge.
- 4 chainmen.
- 2 flagmen.
- 3 axmen.
- 1 cook.
- 1 teamster.

Triangulation party:
- 1 engineer in charge.
- 1 axman.
- 1 packer.
- 1 cook.
- 1 recorder.

Mr. Sargent was directed, after inaugurating the work at Fairbanks, to proceed by trail to Valdez and make the necessary investigations along this route to procure information needed for planning future work in this field.

Mr. Brooks undertook similar investigations in the northeastern part of Kenai Peninsula and in the Matanuska region.

DISTRIBUTION OF TIME OF FIELD PARTIES.

To attain efficient and economic administration, the Fairbanks parties should have gone inland over the winter trail; and had this been done, some field work might have been begun by the 1st of May. As a matter of fact, the money was not available until July 1, and therefore the parties could not leave for the field until that date. Mr. Sargent, Mr. Nelson, and Mr. Lunde, with four chainmen and one recorder, sailed from Seattle on July 5 and arrived at Fairbanks, by way of the White Pass route, on July 22. The field parties were at once organized and the measurement of a base line was begun the following day. Mr. Vance, whose departure from Seattle had been unavoidably delayed, reached Fairbanks on August 8. On August 9 line work was begun by two parties and continued until about October 7. Meanwhile the third party had been engaged in triangulation. Topographic surveys along the surveyed lines was begun about October 10 and continued until about October 20, when stormy weather necessitated the disbanding of the field parties.

Mr. Sargent organized the work at Fairbanks and continued with the parties until September 15. He then spent 14 days in investigating conditions which would affect future surveys in the region traversed by the Valdez-Fairbanks trail.

Mr. Brooks was detained in Washington by office duties until August 3. He sailed from Seattle on August 8 and arrived at Seward

on August 18. Continuing his journey, he arrived at Knik on August 20. From August 21 until September 9 he spent in the Knik Arm and Matanuska region. Returning, he sailed from Seward for Seattle on September 17.

The combined time of Mr. Vance and Mr. Lunde, chiefs of the line parties, from the dates of their leaving the office to their return, was 281 days, a detailed account of which follows:

	Days.
Travel to field and return	113
Measuring triangulation base line and constructing astronomic stations	14
Line work	85
Topographic surveying	21
Field computations and office work	5
Outfitting	3
Stormy weather	14½
Moving camp	12½
Days observed as Sundays	13
	281

Upon Mr. Sargent's departure, Mr. Nelson was left in charge of the field work and thereafter devoted the larger part of his time to administrative duties. He was employed 43 days on field work in connection with the triangulation, 48 days on supervision and computation, 50 days in traveling, and 10 days in outfitting.

RESULTS.

Astronomic determinations.—An astronomic determination of latitude, longitude, and azimuth was made at a station near Fairbanks by the Coast and Geodetic Survey. A similar determination was made at Tanana, a settlement on the west bank of the Yukon, at the mouth of Tanana River. This was in accordance with the approved plans and an agreement made between the Secretary of the Interior and the Secretary of Commerce and Labor under date of July 5, 1910. The Superintendent of the Coast and Geodetic Survey transmitted the results of the final computations of these observations on February 6, 1911.

Triangulation.—A base line was measured and a system of triangulation inaugurated, the geodetic position of which was based on the astronomic observations. This triangulation not only checked the line surveys but can also be extended into adjacent parts of the Tanana Valley to provide points from which land surveys of important areas may be executed in the future. By this means the projection of long standard parallels and guide meridians through areas of no commercial importance will be avoided.

The primary triangulation stations are marked by bronze tablets, furnished by the General Land Office, firmly set in concrete or solid

rock. Preparatory to the future expansion of the triangulation system six signals have been constructed on prominent hills in the Tanana Valley.

Summary of triangulation.

Base line measured	feet..	13,876.674
Primary stations occupied		12
Secondary stations occupied		15
Points intersected		3
Signals constructed		6

Line work.—The line work consisted chiefly of extending base and meridian lines and the survey of township exteriors. Some section lines and a few meanders were also run. The geodetic position of the initial point was determined by triangulation. It seemed desirable not to attempt the sectionizing of the townships until the matter of the rights of the homesteaders had been settled.

Summary of line surveys.

	Miles.
Principal meridians	23.7
Base line	18
Township exteriors	43.7
Section lines	11.8
Meanders	11.7
	108.9

It was impossible to ship iron posts to Fairbanks in time to make them available for the season's work. Wooden posts were therefore set, properly inscribed and witnessed in accordance with the regulations of the General Land Office.

The number of corners set was as follows:

Initial point	1
Township corners	7
Standard township corners	3
Closing township corners	3
Section corners	76
Quarter corners	88
Meander corners	8
Witness corners	8

COST OF SURVEYS.

The expenditures for public-land surveys in Alaska to and including May 15, 1911, were as follows:

Geological Survey	$32.591.02
Coast and Geodetic Survey	2,013.06

The estimated liabilities are $528.19. The total cost of these surveys is therefore $35,132.27.

OFFICE WORK.

Mr. Nelson was furloughed on January 12, thus leaving Messrs. Sargent, Vance, and Lunde to work upon the notes and plats.

The following data were transmitted to the Commissioner of the General Land Office on May 15, 1911: Notes and plats of land lines; results of astronomic observations; notes and results of triangulation base measurements, all corrections being computed; notes and results of the triangulation with least-square adjustment applied.

RECOMMENDATION FOR CONTINUATION OF SURVEYS.

If the policy established last year of surveying the arable lands, especially those which are now being taken up as homesteads, is to be continued, there are three general provinces in which work should be done—the Tanana Valley, the Cook Inlet region, and the Copper River valley.

In the Tanana Valley the subdivision of townships whose exteriors have already been surveyed should be completed and the surveys should be extended by means of the triangulation system into adjacent areas where homesteads have been taken up.

In the Copper River region the positions of the base and meridian lines already surveyed should be astronomically determined, so that the township surveys in this field can be accurately tied to other Alaskan surveys. To obtain an accurate datum for elevations, a line of primary levels should be run from Cordova to Fairbanks. A triangulation should be carried up the Chitina Valley, so as to provide a tie point for subdivisional surveys, which will soon be needed in this field because of the demands of settlers now being attracted by the railway that is under construction. Plans should be made to subdivide the arable lands in the Chitina Valley.

In the Cook Inlet region it seems desirable to subdivide the flats and floors of tributary valleys adjacent to Resurrection Bay. These surveys should be tied to triangulation points of the Coast and Geodetic Survey. It is also desirable to begin township surveys at Knik and at Seward, covering the arable lands of the vicinity. These surveys should also be tied to the Coast and Geodetic Survey triangulation.

If the coal fields are to be subdivided, work should be begun in the Bering River, Matanuska, and Nenana fields. The surveys in the Bering River field should be tied by triangulation to points of known position on the coast. The Matanuska surveys should be tied by triangulation to Coast Survey points on Knik Arm. The Nenana field can readily be reached by extending the Fairbanks triangulation southward.

It is furthermore recommended that authority be obtained, by legislation if necessary, to permit the boundaries of bona fide homesteads to stand as recorded. All the members of the Geological Survey who are conversant with the conditions are agreed that if the rights to lands as recorded by homesteaders are not recognized grave injustice may be done.

THE MINING INDUSTRY IN 1910.

By ALFRED H. BROOKS.

INTRODUCTION.

The gold and copper lode-mining industry of Alaska made considerable progress in 1910, not so much in output as in the amount of dead work accomplished. On the other hand, there was a falling off in the production of the placer mines and an absolute stagnation in all enterprises depending on the opening of the coal fields.

As in previous years, the lack of cheap fuel is the one great hindrance to the advancement of the mining industry in Alaska. So long as the Pacific seaboard of Alaska and the adjacent portions of the inland region have to depend on expensive coal brought from British Columbia, Japan, and Washington, so long will the industries of the Territory suffer. With coal at $8 to $20 a ton along the Pacific seaboard of Alaska, even mines located at tidewater are at great economic disadvantage. Under such conditions only the richest and largest ore bodies can be mined at a profit. Moreover, railway construction will be active only when there is an assured tonnage from the coal fields and when cheap fuel for operating is available.

The inadequacy of the mineral-land laws which apply to placer claims continues to hamper the mining industry by discouraging the bona fide miner and prospector. This condition, while ever present, is emphasized when a new district is discovered and a few men, often mere speculators and not miners, can preempt large tracts of land and hold them for a year and sometimes nearly two years without doing any development work.

In spite of the decreased gold production and the handicap because of the delay in opening the coal fields, considerable advance was made in the mining industry. Copper mining was prosperous and much development work was done on the copper deposits. More has been accomplished than in any previous year in the development of auriferous lodes. Much work was also done toward installing large mining plants for working low-grade placer deposits. The decrease

In the value of the gold production is entirely chargeable to the falling off in the output from the placer mines of Fairbanks, Seward Peninsula, and some of the smaller placer districts. Except in these camps and the coal fields, the output from all the mining districts increased.

The value of the total mineral production in 1910 is estimated at $16,925,178; in 1909 it was $21,141,019. In the following table the sources of this wealth, as well as a comparison with the previous year, are presented. The statistics for gold and silver output are not yet completed and may be subject to change, but the figures for the other mineral products are presented with more confidence as to their accuracy.

It should be noted that the apparent increase in silver production in 1910 as compared with 1909 is due largely to the fact that in the past the silver content of the placer gold has been estimated too low. This is due to the fact that the placer-gold producers make no returns of the silver content of their gold output. The placer silver, which occurs as an impurity in the gold, can be arrived at only by a computation based on the purity of the gold. The accumulation of data on the composition of the placer gold from the several districts during the last six years has made it possible to compute the silver percentage more accurately and has shown that in the statistics published in the past the estimate for placer silver is too low.

In the table the outputs of marble, tin, gypsum, etc., are combined because a separate listing might reveal the production of individual properties.

Mineral production of Alaska, 1909-10.

	1909		1910 [a]		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....ounces..	987,416.76	$20,411,716	781,836.75	$16,162,000	−205,580.01	−$4,249,716
Silver.....do....	147,950.00	76,934	169,418.00	91,485	+ 21,486.00	+ 14,551
Copper.....pounds..	4,124,705.00	536,211	4,241,689.00	538,695	+116,984.00	+ 2,484
Coal.....short tons..	2,800.00	12,300	1,400.00	13,600	− 1,400.00	+ 1,300
Marble, gypsum, tin, mineral water, and lead.....	.....	103,858	.....	119,398	.....	+ 15,540
	.....	21,141,019	.....	16,925,178	.....	− 4,215,841

[a] Preliminary estimates.

NOTE.—In the above table copper is valued at 13 cents a pound for 1909 and 12.7 cents for 1910; silver at 52 cents an ounce for 1909 and 54 cents for 1910.

Mining began in Alaska in 1880, but for many years no very accurate records of mineral output were kept. Since 1905, however, fairly reliable statistics of mineral production are available. These data are summarized in the following table, both by years and by substances:

Value of total mineral production of Alaska, 1880–1910.

By years.				By substances.	
1880–1890	$4,686,714	1901	$7,007,398	Gold	$178,797,171
1891	916,920	1902	8,400,693	Silver (commercial value)	1,286,687
1892	1,096,000	1903	8,941,614	Copper	5,338,709
1893	1,048,570	1904	9,567,535	Coal	336,789
1894	1,305,257	1905	16,478,142	Marble, gypsum, tin, etc.	552,014
1895	2,386,722	1906	23,375,008		
1896	2,980,087	1907	20,847,055		186,311,370
1897	2,538,241	1908	20,142,272		
1898	2,585,575	1909	21,141,019		
1899	5,703,076	1910	[a] 16,925,178		
1900	8,238,294				
			186,311,370		

[a] Preliminary estimate.

TRANSPORTATION.

The nondevelopment of the coal fields has put the railways at a double disadvantage. In the first place, those of the Pacific slope region are paying $11 to $12 a ton for coal used in operating, when high-grade coal should cost them only from $2.50 to $3.50. Moreover, the imported coal is of an inferior quality compared with the native fuels. In the second place, the coal tonnage needed to help support the railways is nonexistent. In spite of these handicaps, the backers of some of the railway projects have shown commendable enterprise in either continuing construction work or preparing for it.

The most important event of the year in the development of transportation routes was the extension of the Copper River & Northwestern Railway to about mile 150. As this report goes to press telegraphic dispatches announce that this railway has been completed to Kennicott, a distance of 195 miles from the coast at Cordova. This affords an outlet for the copper ores of the Kotsina-Chitina district and renders the Nizina placer district readily accessible. It also both shortens the winter sled route to Fairbanks and does away with the necessity of crossing the high coastal barrier. It will also decrease the cost of transportation to the Valdez Creek and Chistochina placer districts and render the copper belt of upper Nabesna and White rivers more accessible. With the changing of the trail from Chitina to Fairbanks into a wagon road, which is now being accomplished by the Alaska Road Commission as fast as funds available permit, an overland summer route to the Tanana camps will be opened. Take it all in all, this is the most important advance made in the history of Alaska transportation since steamboat service was established on the Yukon about half a century ago.

The Alaska Northern Railway did no new construction work because of the coal-land situation, but it maintained communication over its 71 miles of track which connects Seward, the coastal terminal, with the head of Turnagain Arm. By the use of small launches a route

of communication with Knik and points on Susitna River was thus established, which is competitive with the older route from Cook Inlet. Some location surveys were also made beyond the end of the road. This railway, when completed, will lead to the development of the Matanuska coal field and the Willow Creek lode district, as well as other mining districts of the Susitna basin, besides making accessible extensive areas of arable land.

Most of the other railway projects appear to have lain dormant awaiting the settlement of the coal-land question. The completed railways, such as the White Pass, Tanana Valley, and Seward Peninsula, were operated but need no special mention. At the close of 1910 the aggregate length of all Alaska railways was about 420 miles, compared with 371.4 miles at the close of 1909. This mileage is distributed among nine different railways, from 5 to 196 miles in length.

Among the important work accomplished by the Alaska Road Commission, in addition to the continuation of work on the Valdez-Fairbanks wagon road, already referred to, was the preparation for the establishment of a winter trail from the inland terminus of the Alaska Northern Railway to the Innoko-Iditarod region. This will serve the placer miners of the Susitna basin, the Kuskokwim, and the Innoko-Iditarod and will shorten the winter mail route from the Pacific seaboard to Nome by about 300 miles. The commission also built or improved many other roads and trails in different parts of the Territory.

METAL MINING.

INTRODUCTION.

In 1910 about one-quarter of the gold production came from lode mines and three-quarters from placers. It is a significant fact that in 1909 only one-fifth of the gold came from lode mines. The ratio of lode production to placer production has varied considerably during the 30 years that mining has been carried on. In the first two or three years the gold output was almost all from placers. With the opening of the lode mines of the Juneau belt the lode production became larger than the placer, the ratio in 1894 being about 2 to 1. Five years later, when the Nome placers were developed, the ratio of lode to placer output decreased to about 1 to 3. After this the percentage of lode production gradually decreased until 1910, when it began to rise. A further increase in the ratio of gold lode to placer output is to be expected. In the following table, which is based on the preliminary estimates, the metal production has been distributed as to source:

Sources of gold, silver, and copper in Alaska, 1910.

	Tonnage.	Gold.		Silver.		Copper.	
		Ounces.	Value.	Ounces.	Value.	Pounds.	Value.
Siliceous ores	1,400,000	199,595.25	$4,126,000	31,450	$16,983	.....	.....
Copper ores	39,000	1,741.50	36,000	26,300	14,202	4,241,689	$538,695
Placers	.....	580,500.00	12,000,000	111,668	60,300	.....	.....
		781,836.75	16,162,000	169,418	91,485	4,241,689	538,695

In the following table the production of gold, silver, and copper is given by years. The fluctuations in the gold output are chargeable to the discovery of bonanza placer deposits, which at different times in the past have yielded large quantities of gold. This form of mining, while still continuing, will probably in the future contribute a decreasing percentage of the gold production, and as a result there will be less marked fluctuations in the annual output.

Production of gold, silver, and copper in Alaska, 1880–1910.

Year.	Gold.		Silver.		Copper.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Commercial value.	Quantity (pounds).	Value.
1880	968	$20,000			3,933	$826
1881	1,935	40,000			.....	.....
1882	7,256	150,000			.....	.....
1883	14,566	301,000			.....	.....
1884	9,728	201,000	10,320	$11,146	.....	.....
1885	14,513	300,000			.....	.....
1886	21,575	446,000			.....	.....
1887	32,653	675,000			.....	.....
1888	41,119	850,000	2,320	2,181	.....	.....
1889	43,538	900,000	8,000	7,490	.....	.....
1890	36,862	762,000	7,500	6,071	.....	.....
1891	43,538	900,000	8,000	7,920	.....	.....
1892	52,245	1,080,000	8,000	7,000	.....	.....
1893	50,213	1,033,000	8,400	6,570	.....	.....
1894	61,927	1,282,000	22,261	14,257	.....	.....
1895	112,642	2,328,500	67,200	44,222	.....	.....
1896	138,401	2,861,000	145,300	99,087	.....	.....
1897	118,011	2,439,500	116,400	70,741	.....	.....
1898	121,760	2,517,000	92,400	54,575	.....	.....
1899	270,997	5,602,000	140,100	84,276	.....	.....
1900	395,030	8,166,000	73,300	45,494	.....	.....
1901	335,369	6,932,700	47,900	28,598	250,000	40,000
1902	400,709	8,283,400	92,000	48,590	360,000	41,400
1903	420,069	8,683,600	143,600	77,843	1,200,000	156,000
1904	443,115	9,160,400	198,700	114,934	2,043,586	275,676
1905	756,101	15,630,000	132,174	80,165	4,805,236	749,617
1906	1,066,030	22,036,794	203,500	136,345	5,871,811	1,133,260
1907	936,043	19,349,743	149,784	98,857	6,308,786	1,261,757
1908	933,290	19,292,818	135,672	71,906	4,585,362	605,267
1909	987,417	20,411,716	147,950	76,934	4,124,705	536,211
1910[a]	781,837	16,162,000	169,418	91,485	4,241,689	538,695
	8,411,467	178,789,171	2,130,199	1,286,678	33,795,108	5,338,709

[a] Preliminary estimate.

In the following table the total gold production is distributed according to districts, so far as the information at hand will permit. The error in distribution is believed to be less than 15 per cent,

and it is hoped in future statements to eliminate it altogether. The production from the Pacific coast belt is for the most part from the lode mines of southeastern Alaska but includes also a small placer output, as well as the production from a lode mine on Unga Island. The gold credited to the Cook Inlet and Copper River region is, aside from the output of some small quartz mines in the Susitna basin and on Kenai Peninsula, all from placers and includes the yield of the Nizina, Chistochina, Sunrise, Yentna, and Valdez Creek districts.

The gold output of Seward Peninsula and the Yukon basin [1] is nearly all from placers, though there was a small output from the lode prospects of the Fairbanks districts, at least one of which can be classed as a mine.

Value of gold production of Alaska, with approximate distribution, 1880–1910.

Year.	Pacific coast belt.	Copper River and Cook Inlet region.	Yukon basin.	Seward Peninsula and northwestern Alaska.	Total.
1880	$20,000	.....	.....	.....	$20,000
1881	40,000	.....	.....	.....	40,000
1882	150,000	.....	.....	.....	150,000
1883	300,000	.....	$1,000	.....	301,000
1884	200,000	.....	1,000	.....	201,000
1885	275,000	.....	25,000	.....	300,000
1886	416,000	.....	30,000	.....	446,000
1887	645,000	.....	30,000	.....	675,000
1888	815,000	.....	35,000	.....	850,000
1889	860,000	.....	40,000	.....	900,000
1890	712,000	.....	50,000	.....	762,000
1891	800,000	.....	100,000	.....	900,000
1892	970,000	.....	110,000	.....	1,080,000
1893	833,000	.....	200,000	.....	1,033,000
1894	882,000	.....	400,000	.....	1,282,000
1895	1,569,500	$50,000	709,000	.....	2,328,500
1896	1,941,000	120,000	800,000	.....	2,861,000
1897	1,799,500	175,000	450,000	$15,000	2,439,500
1898	1,892,000	150,000	400,000	75,000	2,517,000
1899	2,152,000	150,000	500,000	2,800,000	5,602,000
1900	2,606,000	160,000	650,000	4,750,000	8,166,000
1901	2,072,000	180,000	550,000	4,130,700	6,932,700
1902	2,546,600	375,000	800,000	4,561,800	8,283,400
1903	2,843,000	375,000	1,000,000	4,465,600	8,683,600
1904	3,195,800	500,000	1,300,000	4,164,600	9,160,400
1905	3,430,000	500,000	6,900,000	4,800,000	15,630,000
1906	3,454,794	332,000	10,750,000	7,500,000	22,036,794
1907	2,891,743	275,000	9,183,000	7,000,000	19,349,743
1908	3,448,318	401,500	10,323,000	5,120,000	19,292,818
1909	4,264,716	265,000	[a] 11,580,000	4,302,000	20,411,716
1910	4,237,000	350,000	[a] 8,045,000	3,530,000	16,162,000
	52,261,971	4,358,500	64,962,000	57,214,700	178,797,171

[a] Includes a small production from the Kuskokwim.

LODES.

DEVELOPMENT AND PRODUCTION.

The total gold production from the auriferous lode mines of Alaska which have been productive since 1882 is estimated to be 2,346,635 fine ounces, valued at $48,602,775. These mines have also produced 1,001,241 fine ounces of silver, with a commercial value of $611,808.

[1] This refers, of course, only to the Alaskan parts of the Yukon basin and does not include the production of the Klondike and other Canadian camps.

The total copper production up to the close of 1910 was 33,775,108 pounds, valued at $5,338,709. Tin mining began in the York region in 1902, since which time it has been carried on spasmodically. The value of the total tin product, which has come chiefly from the placers, up to the close of 1910 is $139,639. There has also been some recovery of lead from ores valuable chiefly for other metals.

While the output of the auriferous lodes in 1910 was about the same as that of 1909, marked advances were made in installing mining plants and in prospecting. As a result it is most probable that the lode-gold output in 1911 will be greater than that of 1910 and that the production will increase very much in the next two or three years.

Alaska's auriferous lodes are estimated to have produced during the year 199,595 fine ounces of gold, valued at $4,126,000, as compared with an output of 199,181 fine ounces, valued at $4,117,440, in 1909. The output of the Juneau district was somewhat less than in the previous year, but this is only a temporary setback, for the large amount of development accomplished assures a larger output in 1911. The increased output must be credited to the Sitka, Port Valdez, and other smaller districts. Noteworthy advances in prospecting auriferous lodes were made in the Prince William Sound region, Kenai Peninsula, at Willow Creek, and in the Fairbanks district.

There were 14 productive gold-lode mines in operation in Alaska in 1910, two more than in 1909. Work was also done on more than 50 gold prospects, a few of which produced some gold as an incident to the development work. Of the producing mines six were in the Juneau district.

It is estimated that these mines had an output of 1,400,000 tons of ore, as compared with 1,496,361 tons, the total output for 1909. The decrease in tonnage with an increase in value of gold output indicates the relatively larger percentage of the total made by mines exploiting high-grade ores. In 1909 the average value of gold-silver contents for all the ores mined was $2.72; the average in 1910 is estimated to have been $2.85.

There were six productive copper mines in 1910, as compared with seven in 1909. In addition to these there were several properties which produced some copper incidental to development work. The certainty that the Kennicott-Bonanza mine will be shipping ore in 1911 assures a very large increase in the copper production. Further more, other Alaska copper mines are making preparations to increase their output, and several properties which have not yet been productive will probably begin shipping some ore in 1911. All of this assures a rapid expansion of Alaska's copper-mining industry.

The total copper production in 1910 was 4,241,689 pounds, valued at $538,695, compared with 4,124,705 pounds, valued at $536,211, in 1909. About $36,000 worth of gold and $14,202 worth of silver was

recovered from the copper ores. It is estimated that in 1910 about 39,000 short tons of copper ore was hoisted, as compared with 34,669 tons in 1909. The average copper content of the ore was about 5.4 per cent and the gold-silver values about $1.29 to the ton.

SUMMARY OF LODE MINING BY LOCALITIES.

PACIFIC COAST REGION.

Except for a small production at Fairbanks, all of the auriferous-lode gold came from mines situated on the Pacific seaboard or in the drainage basins tributary to it. Lode mining, especially that of the Treadwell group of mines, in the Juneau district, continues to overshadow all other enterprises of this kind. Mr. Knopf on pages 94–111 summarizes the mining developments of the year in southeastern Alaska.

Kotsina-Chitina district.—The most important event of the year in the Kotsina-Chitina copper district was the extension of the Copper River & Northwestern Railway, already referred to on page 23. As this report goes to press (April, 1911) a telegraphic dispatch from Cordova announces that the first train load of copper ore has been shipped to the coast from the Kennicott-Bonanza mine. This is one of the most important events in the history of Alaska's mining industry, as it assures the opening of a region which promises to become an important producer of copper.

The Kennicott-Bonanza is now fully equipped to ship ore, of which a large quantity of extraordinary richness has been blocked out. The deepest workings are from 150 to 160 feet below the surface. During 1910 the most important development was the construction of ore bins and a concentrator at the railway terminal, which is connected with the mine by an aerial tram 15,000 feet in length.

The assurance of a railway has led to much prospecting of other claims in the Kotsina-Chitina district, detailed information in regard to which is, however, lacking at this writing. It is reported that the development work done on the Mother Lode group of claims, which lie on the McCarty Creek side of the Bonanza divide, has opened some very promising ore bodies. The work accomplished in the Kotsina region, at the west end of the copper belt, is also reported to have developed some good ore bodies. Up to the present time the aggregate amount of rock work accomplished, outside of the Kennicott-Bonanza, has been very little, but now that quick and comparatively cheap transportation is assured, more systematic development will undoubtedly be undertaken.

Lower Copper River basin.—The Bremner and Tiekel regions of the lower Copper River basin have long been known to carry auriferous gravels, some of which have been mined in a small way. In 1910

some auriferous quartz veins were found in this district. So far as known, their geologic occurrence is similar to that of the veins of Port Valdez. Interest in gold-bearing lodes was revived in the McKinley Lake region in 1910 by some new discoveries. These discoveries are a few miles north of Algonik, a station on the Copper River & Northwestern Railway about 22 miles from Cordova.

Prince William Sound.—The most important event of the year in the Prince William Sound region was the development of an auriferous lode mining district on Port Valdez. Though some of the gravels of this region have long been known to be auriferous, little search was made for lode deposits until 1909 and no commercial ore bodies were developed until 1910. The most important prospects thus far discovered lie in an area bounded on the east by Valdez Glaciers, on the south by Port Valdez, on the west by Shoup Bay and Shoup Glacier, and on the north by a less well defined line lying 2 to 5 miles from tidewater. Some prospects have also been located on the south side of Port Valdez. Within this area more than 200 lode claims have been staked, most of them during 1910. As during all other periods of mining excitement, only a small fraction of these claims can be expected to contain commercial ore bodies. The facts that one mine has been opened, that several other prospects have been sufficiently developed to give promise of carrying commercial ores, and that auriferous mineralization is widely distributed augur well for the future of the district.

The Cliff mine, the only property which has been put on a productive basis, is located near the eastern entrance to Shoup Bay, about 8 miles west of the town of Valdez. The claim was staked in 1909 (?), development work began in July, 1909, and a 3-stamp mill, said to have a capacity of 30 tons a day, was installed in April, 1910. As, however, up to the time of the writer's visit (August, 1910) only one concentrating table was in use, the mill had been run only two shifts (16 hours) each day. The mine was operated until December, when it was temporarily closed, but work was resumed in January, 1911.

The following notes are based on a hasty visit:

The country rock at the mine appears to be chiefly dark siliceous slate, in places graphitic and usually blocky. At the beach the strike is about east and west and the dip 20° to 30° N. The slate carries mica and is in places heavily charged with finely divided pyrite, which occurs in veinlets cutting the foliation and is also disseminated especially along the cleavage planes. There has been movement later than the pyrite, as is shown by slickensided surfaces about parallel to the cleavage.

The vein cuts across the foliation of phyllites with a strike of about N. 30° to 45° W., averaging about N. 35° W. It dips southwest at

an angle of about 50° to 70° but has some rolls in it. The footwall is smooth and along it there is from half an inch to 3 inches of gouge which carries values. There seems to have been no movement along the hanging wall, but it is well defined. The vein varies in width from, say, an inch, where quartz may be entirely lacking, to 34 inches. The managers report that small swellings occur where the vein widens out to 3 and 4½ feet. The vein matter is in places entirely lacking, but the fissure is everywhere well defined. In one place in the upper tunnel a roll was encountered where a bulge in the footwall gave a reverse dip to the vein. On the whole, the strike of the vein is fairly uniform in direction, though the workings show minor swings of 5° to 10°. At the upper prospect tunnel, about 150 to 200 feet above the beach, what appears to be the same vein has a thickness of about a foot. So far as determined by the exposures, the vein is definitely recognizable for about 300 to 400 feet, but the managers stated that it has been traced by float throughout the length of the claim, and it is reported that the same vein has been found on the north side of the ridge, a distance of probably 3,000 feet from the mine.

The typical vein filling is a blue quartz carrying considerable finely disseminated pyrite and also apparently minute quantities of arsenopyrite and galena, but no detailed study of ore has been made. Visible free gold is found, especially in the upper workings, where there has been considerable oxidation. Free gold occurs, however, in the fresh, unaltered vein material, where it is clearly not the product of alteration. In places the ore shows a rough banding, and this type is reported to carry the highest values. Some of the vein material is crushed and some shows a suggestion of brecciation and recementation.

Much of the ore is very rich, and the average recovery of free gold is currently reported to be about $50 to the ton. The manager reports no noteworthy change in values between the upper and the lower workings. The concentrates are said to run about 7 per cent and to have a value of about $100 a ton in gold.

Oxidation of vein matter is very marked on the upper level and was observed on the lower level to a distance of about 100 feet from the entrance of the adit. Beyond 100 feet on the lower adit there was no evidence of oxidation. The superintendent, Ray Millard, stated to the writer that there was no diminution in free-gold values at depth. At the same time the richest specimens of free gold seem to have been taken from the upper part of the mine. Values of $1.50 to $6 are reported in the hanging-wall rock, in which many quartz stringers were observed extending a distance of a foot or more from the vein. In the upper adit the vein matter is absent from the last 50 feet, but the fissure is traceable. It is in this part of the mine that the roll occurs.

There are two adit tunnels (which are connected by raises) 54 feet apart and one intermediate drift. Plans are made for sinking on the vein in the lower tunnel. There is also a prospecting tunnel which is 150 to 200 feet above the beach. The lower adit is about 200 feet long. According to the manager, a winze has been sunk to a depth of 50 feet below the lower adit since the writer's visit. At this depth the ore body seems to maintain itself and there are reported to be no notable changes in gold tenor.

No exact information is available regarding the many other properties which have been more or less prospected. Along the shores of Port Valdez, near the Cliff mine, are a number of veins, some of which have been developed by adit tunnels, but these were not examined by the writer. At the Imperial an adit has been driven along the vein for a hundred feet, and since the writer's visit an air compressor has been installed. A 3-stamp mill has also been erected near this point and probably on this property. In the fall of 1910 prospecting was being pushed on six or seven properties located on Mineral Creek. Of these the Williams-Gentzler property, about 4½ miles from the beach, is said to be one of the most promising. Here a well-defined 18-inch quartz vein carrying high gold values is reported. A wagon road has been completed from Valdez to Mineral Creek and up that stream about 4 miles.

There has also been considerable gold-lode prospecting in other parts of Prince William Sound. Encouraging results are reported from Jackpot Bay and from McClure Bay, both on the west side of the sound.

In the aggregate there was considerable work done on the copper lodes of Prince William Sound, though the low price of copper rather discouraged any except the strong companies from putting their properties on a shipping basis. Work was continued on the properties on Landlocked and Galena bays, though so far as known they made no shipments.

The Glacial Island Copper Co. is said to have opened a body of high-grade chalcopyrite ore by a tunnel 170 feet in length. The vein is said to be 4 feet wide and to be exposed 150 feet above the tunnel. A small bunker has been built and the managers report that some shipments will be made in 1911.

At the Beatson-Bonanza mine, on Latouche Island, ore bunkers having a capacity of 1,500 tons were built and a small water-power plant installed. A diamond drill is being used for prospecting. Ore shipments have continued throughout the year. A compressor plant with air drills has been installed on the property of the Seattle Alaska Copper Co. near Big Bay. The managers report that a 10-stamp mill and concentrating table are to be installed to concentrate the lower-grade ores. At Ellamar a horseshoe-shaped coffer-

dam 400 feet in length and 20 feet above low tide is being completed. A steam pumping plant has been installed and shipments of ore were made in 1910.

Kenai Peninsula.—There was great activity in quartz prospecting on Kenai Peninsula in 1910, but this district was not studied by the Geological Survey. The following notes are gleaned from numerous sources. Of the many properties which were developed to some extent, those of Watson & Snow, now incorporated under the name Wanowski Gold Mining Co., near Moose Pass, showed the greatest results. On this property several hundred feet of underground work has been accomplished, work having been done on one large quartz vein and another small one, which are parallel. The larger vein is well defined, having been traced for about a mile. Plans have been formulated for erecting a stamp mill in 1911.

On False Creek the California-Alaska Mining Co. continued work on a gold-bearing quartz prospect, where an air compressor has been erected. Work was also continued on the Stevenson property, in the same neighborhood. Auriferous quartz veins have been staked at many other places in the Sunrise placer district, but these have been for the most part little developed, except for the annual assessment work. What appears to be a promising auriferous quartz vein was found north of Turnagain Arm, at the head of Crows Creek. This vein is reported to be 2 to 4½ feet in width, of which 12 to 14 inches carries very high gold values. It is said to have been traced for several hundred feet. The specimens from this lode seen by the writer showed free gold and iron and arsenopyrite, with a gangue of well-developed interlocking crystals of quartz.

It appears from the information at hand that the quartz veins of Kenai Peninsula are similar in their geologic relations to those of Prince William Sound. There is, however, more than one type of vein filling. One of the lodes in the Moose Pass district appears to be a mineralized dike and hence of a different type from the other deposits which have been opened. At the Cliff mine, in the Port Valdez district, the values are largely in free gold, while in the Kenai Peninsula veins more of the gold is combined with the pyrite. Further study of these deposits will have to be made before more definite comparisons can be made.

Willow Creek.—The lode-mining developments of the Willow Creek region, north of Cook Inlet, are described by Mr. Katz on pages 139–150. These occur along the marginal contact of the great mass of granite which forms the Talkeetna Mountains. Prospectors report the occurrence of metal-bearing lodes in other parts of this contact zone, but little is known about them and they are practically undeveloped. Such lodes are said to occur on the upper part of Granite Creek and on Little Willow Creek. On Iron Creek, a tributary of the

Susitna, a lode has been found which carries chalcopyrite and pyrite, with copper and gold values. This is reported to occur at the contact of slate and greenstone, not far from the outer margin of the granite mass.

Southwestern Alaska.—There are but few mining developments in southwestern Alaska. Prospecting continued on the copper deposits of the Iliamna region and some steps were taken to open an auriferous lode on Popof Island. About 15 men were employed at the Apollo mine, chiefly in development work, but some ore was taken out. Some prospecting of auriferous lodes was also done on Kodiak, Dry, and Afognak islands.

YUKON BASIN.

Although many lode claims have been staked in the Yukon basin, there was little actual prospecting in 1910 and no developments of importance except in the Fairbanks and Chandalar districts. The completion of a 10-stamp customs mill with full equipment at Chena in November, 1910, has stimulated auriferous-lode development. Most of the actual lode-gold production came from the smaller mill at Fairbanks, which was operated at intervals during the year. One arrastre was also operated a part of the summer season. At this writing complete returns are not available from all the lode-mining operations, but it is estimated that probably about 200 tons was milled, yielding about $20,000 in gold, besides the concentrates and some values in silver. Detailed notes in regard to all the properties are lacking. The following data are based in part on information collected by G. L. Parker, incidental to his investigations of the water supply of the Fairbanks district.

The most important developments were on the Free Gold mine of Rhodes & Hall, located near the head of Cleary Creek. A part of this property was worked under lease and a part by the owners. The main adit tunnel, which follows the ledge, is reported at the close of the year to have been driven over 630 feet, and a shaft has been sunk about 50 feet, together with a 90-foot crosscut. In this distance the ledge has been lost once or twice through pinching or faulting but has been picked up again. The ledge varies from a few inches up to 4 feet in width and has been traced on the surface for a distance of about 1,000 feet. The greatest depth of the workings below the outcrop of the lode is about 250 feet, and to this depth there is apparently no change in the character of the ore.

An adit tunnel has been driven for about 300 feet on the property of the Tanana Quartz & Hydraulic Co., whose ledge (so far as known about 10 inches wide) parallels that of the Free Gold and lies close to it. On the "Carlisle fraction," which is also close at hand, a shaft has been sunk about 50 feet and some crosscuts have been driven.

Some rich ore was milled from this property, which was chiefly picked up on the surface.

Work has been continued by the Tolovana Mining Co. on its claims, where an 85-foot adit tunnel was driven, and some rich ore was mined and milled at Fairbanks. No data are at hand regarding the thickness of the ledge. This company is preparing to erect a stamp mill. Work has been continued on the Jupiter-Mars property, in the same neighborhood, where a 70-foot adit tunnel and 50-foot crosscut have been completed. Some work was also done on another group of claims on Willow Creek by Hershberger, Beall & Phipps, in the course of which some rich ore was taken out. No data are at hand regarding the thickness of the veins.

No work was done on the property of the Rex Mining Co. (Butler & Petree) on Chatham Creek, because of litigation. The total development to date includes a 160-foot inclined shaft with several prospecting levels. The vein is reported to be 4 to 8 feet in width. The property of the Pioneer Co. has been leased and some prospecting was done. On the Soo claim (W. L. Spalding) a 125-foot adit tunnel has been driven and a shaft sunk to a depth of 30 feet. The vein is about 15 inches wide. Some ore milled from this property gave good returns. On the adjacent Waterbury claim a 55-foot shaft has been sunk to develop a 3-foot vein, which yields good values in gold. The ore taken from this property in the course of development was sent to the mill and a 200-foot crosscut was driven. Some rich ore was taken out of a claim on Wolf Creek by Horton & Solomon.

Some open cuts were made on a lode located on the divide between Wolf and Fairbanks creeks, which was discovered in 1909. This property is owned by Lawrence McCarty and Frank Lawson. Some rich ore was taken out and milled at Fairbanks. The thickness of the lode had not been determined at the time of Mr. Parker's visit in August. In July and August five ledges were discovered on Fairbanks Creek. These seem to follow two systems of fissuring, one paralleling the creek and one about at right angles to this direction. They carry gold, galena, and stibnite. On the Excelsior claim a 7-foot vein is reported, according to the mining press, carrying $10 to $20 in gold and $15 to $30 in silver to the ton. Another vein is chiefly galena, with reported gold values of $5. Some ore was shipped to Fairbanks from these properties. The development work seems to have consisted chiefly of open cuts.

Two lodes about 300 feet apart have been located by Louis Friederich on the divide between Vault and Dome creeks. The westerly one has a granite-dike hanging wall and varies, so far as the small amount of surface work admits of determination, from 20 inches to 3½ feet in width. The easterly vein, which has been traced for about 800 feet, is from 3½ to 8 feet wide. It has been crosscut by an adit tunnel.

Both veins carry gold values and several tons of ore have been milled. These veins contain considerable stibnite. Since Mr. Parker's visit these prospects have been further developed and others have been opened in the vicinity.

Among other prospects reported is a 3-foot vein called the Hidden Treasure, near the head of Little Eldorado Creek, developed by a 140-foot tunnel and carrying high gold values, and another in the same vicinity on which a 38-foot shaft has been sunk and which is said to be 5 feet wide. Some ore has been milled from these properties.

Some developments were made on the claims of Whitman & Murray at the junction of Skoogy and Twin creeks. Here there are two shafts, 40 to 50 feet deep, and about 400 feet of drifts and crosscuts. An arrastre was built in 1910, with which considerable ore was milled.

The above notes indicate that considerable advance was made in lode mining during the year. Most of the veins opened are small and carry high values. The developments on the Free Gold property indicate that some of the veins, at least, have a persistence which is encouraging. There is good reason to think that the geologic conditions are the same throughout that part of the Fairbanks district where lodes have been found. All this, together with the presence of the rich gold placers, favors the belief that workable lode deposits will be developed.

The development of auriferous quartz veins continued in the Chandalar district in 1910. Conditions of transportation were somewhat improved in this district by the completion of 90-odd miles of trail from Beaver, on the Yukon, to Old Caro. In spite of the immense cost of transportation, a small 3-stamp mill was erected on the Gold King claims, owned by T. S. Haynes and E. W. Griffin, on Big Creek. This mill was erected with only a very insecure foundation, because of the high cost of timber, the nearest being 18 miles distant. Some ore was put through this mill. The Alaska-Chandalar Mining Co. continued development work on its property on Squaw Creek, on which the lode is reported to be from 4½ to 8 feet wide and to carry high gold values. A 4-stamp mill has been delivered at Beaver, on the Yukon, for this company and will be sledded in during the winter of 1911–12. The men who are developing this remote district in the face of such serious obstacles, including difficulty of transportation and lack of timber and fuel, merit the highest praise and support.

GOLD PLACERS.

INTRODUCTION.

The value of the placer-gold production of Alaska for 1910 is estimated at $12,000,000, as compared with $16,212,000 in 1909. The difference between these two amounts is almost exactly the

sum of the decreased production of the Seward Peninsula and Fairbanks placers in 1910 as compared with 1909. This, however, does not tell the whole story, for in 1910 the output of the Fortymile, Rampart, and Koyukuk was less than in the previous years, but this loss was more than made up by the increased output of the Innoko-Iditarod region, whose production was more than double that of 1909. There were also small increases in the output of the placer camps of the Pacific slope as compared with previous years.

Among the most encouraging features of the year's placer mining are the large increase in the gold production of the Innoko-Iditarod region, the discovery of a new auriferous district in the Squirrel River basin of northwestern Alaska (see pp. 306–319), and the continuation of activity in the installation of dredges in Seward Peninsula. On the other hand, the delay in installing plants to exploit the extensive deposits of auriferous gravels in the Fairbanks district, whose gold values are too low to permit profitable exploitation by present mining methods, has not been encouraging. A large annual production has been maintained in the Fairbanks district up to the present time by the output from bonanza placer deposits, but deposits of this character are being rapidly depleted, and unless steps are taken to mine the gravels of lower grade, the output of the camp must continue to decline. Some advance, however, was made in the Fairbanks district, where a small dredge was built and preparations were made to install several large dredges in 1911.

In the following table the approximate yardage of the total bulk of gravels mined in Alaska during the last three years is presented, together with the value of the gold recovered per cubic yard. While these estimates are little more than scientific guesses, they are certainly near enough to the truth to indicate the order of magnitude to which the true figures belong. The estimated quantity of gravel mined is intended to include only that which is passed through the sluice boxes. Obviously, in open-cut mining any overburden which may be removed by shoveling, mechanical means, or ground sluicing will not be included in these totals.

Estimate of total amount of gravel sluiced in Alaska placer mines and value per cubic yard of gold recovered, 1908–1910.

	Total quantity of gravel (cubic yards).	Value of gold recovered per cubic yard.
1908	3,500,000	$4.45
1909	4,020,000	4.00
1910	3,800,000	3.20

These figures clearly indicate the improvement in mining methods which each year permits the exploitation of gravels of lower gold

tenor than in the preceding year. If figures for the earlier years of placer-mining operations were available, the decrease in average gold content would be still more striking. For example, it has been estimated that the average gold content of the gravels mined on Seward Peninsula during the nine years ending in 1906 was about $5.95 a cubic yard,[1] while gravels mined on the peninsula in 1908–1910 yielded an average of $2.85.

There is probably no better evidence of the future of the Alaska placer-mining industry than the above figures. Every reduction in cost of mining means the making available for profitable exploitation of more auriferous gravels. These gold values in the gravels mined are still more striking when compared with the average gold content of the gravels mined in the States. According to Waldemar Lindgren, the average gold recovery from all the placer mines in the States for the year 1909 was about 12 cents a cubic yard.

SUMMARY OF PLACER MINING BY LOCALITIES.

PACIFIC COAST REGION.

For the purposes of this discussion the Pacific coast region will be made to include not only the seaboard but all the drainage basins tributary to it, including the Copper and Susitna. The placers of this province are estimated to have had in 1910 an output valued at $425,000, as compared with $330,000 in 1909. This increase is to be credited to the small districts of the region, of which the Yentna is the largest producer.

Southeastern Alaska.—A little placer gold was mined during 1910 on Gold Creek, near Juneau, but the only important mining ventures in this part of Alaska are those of the Porcupine district, lying about 40 miles from tidewater, on Lynn Canal. The largest operations in this field were those of the Porcupine Gold Mining Co., which operated its hydraulic plant for a good part of the season. A high-line flume was completed and a bedrock drain was extended 2,000 feet in 1910. The Cahoon Creek Placer Mining Co., in the same district, accomplished much dead work, including the building of flumes. Its plant was completed in time to do considerable hydraulicking. In addition to these, there were some smaller operations in the district.

Beach mining.—Beach mining was continued at a number of localities scattered along the Pacific seaboard from Lituya Bay to Unga Island. A large part of the gold recovered in this way comes from the Yakataga beach placers. In the past the relatively small bulk of auriferous gravels contained in the beaches has discouraged all but individual operators, who, for the most part, use the rocker. During 1910, however, steps were taken to organize a company to mine some of these beach placers on a larger scale.

[1] Collier, A. J., and others, Gold placers of parts of Seward Peninsula: Bull. U. S. Geol. Survey No. 328 1908, p. 136.

Copper River region.—The placers of the Chistochina district are described by Mr. Moffit on pages 112–137. Two hydraulic plants were operated in the Nizina district, besides a number of smaller plants. The output, which can not be published because it might serve to indicate the production of individual operators, was nearly twice as large as that of 1909. With the completion of the Copper River & Northwestern Railway this district will become readily accessible and an increased gold production is to be expected.

Sunrise district.—The placer-mining industry of the Sunrise district, including the northern part of Kenai Peninsula, had a prosperous season. This is shown not so much in the actual gold production, which is still small, as in the fact that initial steps were taken on several of the creeks to undertake mining on a large scale. These enterprises include plans for installing dredges and also for systematically exploiting groups of creek or bench claims by hydraulic methods. It is well known that there are extensive deposits of auriferous gravels whose values are too low to permit profitable exploitation by open-cut and manual methods.

During 1910 there were some half a dozen hydraulic plants, large and small, in operation in this district. One of the largest of these is on Crow Creek, where the operations of the year consisted largely in removing the heavy overburden, which covers the gold-bearing gravels, by hydraulic methods. In addition to the hydraulic mines, 15 or 20 smaller operators made some gold output.

Susitna basin.—There are in the Susitna basin three productive placer districts—Willow Creek, described by Mr. Katz on pages 150–152; Valdez Creek, described by Mr. Moffit on pages 119–124; and the Yentna district. The Yentna had the most profitable season in its history. Here placer gold has been found in three distinct areas in a belt some 20 miles long, which embraces the foothills of the Alaska Range. The most southwesterly of these includes the placers which have been found on Nakochna River, near the mouth of Kellar Creek, and on Eagle and Independence creeks, which join Yentna River. Here only a small amount of mining has been done so far. A second gold-bearing area includes the placers of some of the tributaries of Lake Creek, which have been mined only on a small scale. The third and up to the present time the most important gold-bearing area in this district is that drained by Cache and Peters creeks. The Cache Creek Mining Co. completed the installation of a hydraulic plant in 1910 and did considerable mining. Another company carried on large operations on Nugget Creek. The success of these larger plants has encouraged the investigation of other properties with a view to introducing improved methods. It is estimated that about 200 men were engaged in mining and prospecting in the entire district.

MULCHATNA REGION.

Mulchatna River heads in an unsurveyed area northwest of Lake Clark and flows into Bristol Bay. Gold has long been known to occur in its drainage basin, and some promising prospects are reported to have been discovered in 1910. The region is rather difficult of access, involving either a canoe trip from Cook Inlet via Iliamna and Clark lakes, with numerous portages, or a long upstream boat trip from Bristol Bay. In 1910 a steamboat was built at Bristol Bay for use on the Mulchatna. There are said to have been between 25 and 50 prospectors in this district in 1910.

YUKON BASIN.

The value of the placer production of the Yukon basin, including the Innoko-Iditarod region, in 1910 is estimated at $8,020,000, as compared with $11,580,000 in 1909. This falling off is due largely to the decreased production of the Fairbanks district, the value of whose output was $6,100,000[1] in 1910 and $9,650,000 in 1909. The mining industry of the placer camps of the Yukon-Tanana region, including Fairbanks,[2] is described by Messrs. Ellsworth and Parker on pages 153–172 of this volume. Mr. Maddren describes the Innoko-Iditarod region on pages 236–270. It will therefore only be necessary here to refer to the remaining districts, which include those of the lower Yukon, the Chandalar, and the Koyukuk.

Mining continued in 1910 in a small way in the Gold Hill district, which is near the mouth of the Tanana. Nothing of importance was accomplished, except preparations for mining on a larger scale than had hitherto been attempted. In the Chandalar district only three placer claims were worked in 1910. Interest centered on lode prospecting, which is referred to on page 35. Accurate figures of the gold output of the Koyukuk in 1910 are lacking at this writing, but it certainly was much less than that of 1909. This was due to the fact that the output of 1909 was far above the normal, because of the output of one or two rich spots on Nolan Creek, which were quickly mined out. According to current reports, some rich gravels were found during the year on Sheep Creek. Of perhaps greater significance is the reported occurrence of gold placers on Old Man Creek, a southerly tributary of the middle Koyukuk. It is estimated that about 300 men were engaged in mining and prospecting on the Koyukuk in 1910.

KUSKOKWIM REGION.

The influx of population to the Innoko-Iditarod region has led to considerable prospecting in the adjacent parts of the Kuskokwim

[1] This does not include gold to the amount of over half a million dollars from other districts which passed through the town of Fairbanks.

[2] Lode mining is described on pp. 33-35.

basin. A trading post and settlement named Georgetown has been established on the Kuskokwim, about 325 miles above the Lelenaw anchorage, the highest point on the river reached by ocean-going vessels of any considerable size, and about 450 miles from Goodnews Bay, the nearest good harbor on Kuskokwim Bay. Georgetown affords a supply point for the Kuskokwim, and as a result there has been considerable prospecting in this general region.

The streams joining the Kuskokwim from the north near Georgetown head in the Innoko-Iditarod region and are known to carry auriferous gravels, though these have not yet been productive. (See pp. 267–269.) Some gold has also been found on the Holiknuk, a tributary of the Chulitna, which flows into the Kuskokwim from the south 15 or 20 miles below Georgetown. Some placer mining was done in 1910 on Bear Creek, in the basin of Toluksak River, tributary to the Kuskokwim from the east about 20 miles above Bethel. The extent of these operations is not now known. In 1900 the discovery of placer gold in the Goodnews Bay region attracted a number of prospectors, but interest soon flagged and prospecting was abandoned. This region has again attracted prospectors, and it is reported that in 1910 some claims made a gold output. All these discoveries lie in what would be the southwesterly extension of the Innoko-Iditarod region, and this fact alone would appear to justify further prospecting.

NORTHWESTERN ALASKA.

The region here termed northwestern Alaska includes the Kobuk region, where a little placer mining was carried on in 1910 (see pp. 271–319); the Norton Bay region, where there was little or no productive mining; and Seward Peninsula, which is, in spite of its decreased output, still second only to Fairbanks in the value of its annual gold output.

The value of the gold production of Seward Peninsula in 1910 is estimated to be $3,500,000, as compared with $4,260,000 in 1909. In spite of the decreased output the mining industry, in view of the large amount of dead work accomplished, can be said to have had a prosperous year. Ten new dredges were installed, of which nine were operated for a part of the season, in addition to seven dredges built in previous years, which were also operated. About $1,400,000 worth of gold was mined during the winter season, and about $1,000,000 of this in the region immediately tributary to Nome. Of the total output, some $2,200,000 is to be credited to the Nome precinct, including the Solomon River region. The Fairhaven precinct probably made an output worth half a million dollars, and the Council precinct somewhat less. The rest of the gold is to be credited to the placer mines of the Kougarok and Port Clarence precincts.

As already stated, dredging was the important feature of the year's mining industry. Three dredges were installed in the region tributary to Nome, making five in all for this district, of which four were operated. Four dredges were operated in the Solomon basin, of which two were built in 1910. Two new dredges and three old ones were operated in the Council region, and one new one in the Casadepaga basin.

Details regarding the operations of all these dredges are not available at this writing. It appears, however, that the 16 dredges, including the nine new ones, some of which were only completed in time for a brief test, were operated from 10 to 130 days, each averaging 58 days. The daily capacity of these dredges varies from 1,000 to 5,000 cubic yards, and they are equipped with a total of about 2,500 horsepower. The buckets vary in capacity from 2½ to 9 cubic feet, though all but five of the dredges have buckets of 3½ cubic feet or less. Two are driven by electric power, generated at one plant; seven are equipped with steam power, of which four use coal, two crude oil, and one wood. The other dredges are equipped with gasoline engines. It is estimated that the 16 dredges operated handled between 1,200,000 and 1,500,000 cubic yards of gravel, and had they all been able to operate to their full capacity they should have handled at least twice as great a yardage. It is a significant fact that the estimated bulk of gravel handled by all other forms of placer mining on the peninsula in the year 1910 is roughly estimated to have totaled 600,000 to 800,000 cubic yards. Complete returns are not yet available regarding the gold output of the dredges, but it is estimated to have a value of about $800,000. It seems probable that the average working season should be 110 to 130 days instead of 90, as has been the case in the past. If this is true, the dredge production can be largely increased even without any additional machines. Plans have already been formulated for the building of three or four dredges in 1911. If this is accomplished and the existing plants all prove efficient, it is not impossible that the output of the dredges alone in Seward Peninsula may soon reach $2,000,000. There is hope, therefore, that the gold output of the peninsula in 1910 may be the minimum for some time to come. The profits on dredging could be increased if power were furnished from one or two central stations. A further reduction in costs would be made by centralizing the management and by building dredges of the same type with interchangeable parts.

There is no question that there is a large amount of gravel suitable for dredging on Seward Peninsula and that this form of mining is likely to increase very much. It is unfortunate that the legitimate and well-managed projects often have difficulty in procuring the necessary capital because of a number of conspicuous failures. A

certain class of promoters apparently believe that it is unnecessary to determine the presence of gold values, the thickness of the gravels, and the distribution of ground ice before installing a dredge. This point of view is probably sometimes forced on the local managers by the nonresident stockholders, who are so desirous of quick returns that they are willing to do the prospecting after the dredge is constructed. There is probably no phase of placer mining which requires such careful study of conditions and prospecting of gravel by competent engineers as does that of dredging.

While dredging was the most important industry of the peninsula during 1910, other phases of mining were not neglected. The Pioneer Co. purchased the Miocene ditch and used the water on several properties in the Nome region. Hydraulic plants were also operated on Bangor and Boulder creeks. The season's operations in the Kougarok precinct were especially successful because there was more water available than in any previous season for several years. The Taylor Creek Ditch Co., the largest operator in this district, was engaged in hydraulicking some bench gravels on Kougarok River. The Fairhaven Ditch Co. also had a successful season in the northeastern part of the peninsula.

COAL AND OIL.

Practically nothing was done in the coal fields except a few patent surveys. Most of the small mines which have in the past furnished lignitic coal for local use were in 1910 closed until the matter of granting patents should be finally decided. On the other hand, some new drilling was done in the Katalla oil field. Some oil properties were leased and preparations were made to render the field productive.

BUILDING MATERIAL, ETC.

Work continued on the only developed gypsum deposit in Alaska, located on the east side of Chichagof Island, in the Sitka district. The large marble quarry located at Shakun, at the north end of Prince of Wales Island, continued shipments throughout the year. Some small shipments of garnets were made from the Wrangell district, in southeastern Alaska, in 1910. An investigation was made of the sulphur deposits of Makushin Volcano, on Unalaska Island, at the east end of the Aleutian chain, to determine the feasibility of mining them.

GEOLOGIC FEATURES OF ALASKAN METALLIFEROUS LODES.

By ALFRED H. BROOKS.

INTRODUCTION.

Thirteen years of systematic investigation of the mineral resources of Alaska by the Geological Survey has yielded a large amount of information relating to the geology of the mineral deposits. This has been used for the most part only in the descriptions and discussions of the economic geology of the individual districts about which reports have been published. Heretofore relatively little attention has been paid to the relation of the mineral deposits of different parts of the Territory to one another or to other broader problems of economic geology. Practically the only exception is the geology of the coal fields, which has been briefly summarized.[1] Therefore anyone desiring information about the areal distribution and geologic occurrence of the metalliferous deposits must seek it in nearly two score publications.[2]

It is proposed to summarize briefly in this paper the salient geologic features of the metalliferous deposits of Alaska, using the results obtained by the many geologists who have worked in this field. As the facts and their interpretation are taken largely from published reports, it will be evident that this article can lay no claim to being an original contribution to the geology of the ore deposits. It is hoped that the matter presented will be useful, not only to those who are developing the metallic wealth of the Territory, but also to those who may desire a convenient outline of the more purely scientific results which have been achieved.

Alaska is rich in metallic wealth. Its lode and placer mines up to the close of 1910 have produced[3] about 8,411,467 fine ounces of gold, valued at $178,789,171; 2,130,199 fine ounces of silver, valued at $1,286,678; 33,795,108 pounds of copper, valued at $5,338,709; and about $100,000 worth of tin. The rapid advance of the mining

[1] Brooks, A. H., The coal resources of Alaska: Twenty-second Ann. Rept. U. S. Geol. Survey, pt. 3, 1902, pp. 515-571. Martin, G. C., The Alaska coal fields: Bull. U. S. Geol. Survey No. 314, 1907, pp. 40-46 Brooks, A. H., Alaska coal and its utilization: Bull. U. S. Geol. Survey No. 442, 1910, pp. 47-100.

[2] See list of publications at end of this volume.

[3] Statistics of mineral production are presented in detail on pp. 24-28.

industry, which had its beginning in 1880, is indicated by the fact that over 80 per cent of the gold, almost 75 per cent of the silver, and all of the copper and tin have been produced during the last decade.

The lode production, which is the more important to the subject of this paper, includes all the copper, 2,346,635 fine ounces of gold, valued at $48,662,775, and 1,001,241 fine ounces of silver, valued at $611,608. Of this amount, the copper, 1,544,916 fine ounces of gold (value $31,845,549), and 452,190 fine ounces of silver (value $262,630) have been produced in the last 10 years. Most of the tin is from placers, but there has been a small output from lodes.

The above statistics of the output of precious metals serve only to indicate the advancement in productive mining. Of more importance to the future of the industry is the large amount of work accomplished during the last few years in prospecting and developing lode deposits. This is true not only of long-established lode-mining camps on the Pacific seaboard but also of many inland districts. These developments are constantly adding new facts bearing on the occurrence of metalliferous lodes, and hence a paper like the present one can be regarded only in the nature of a progress report, which should be succeeded by others after more exhaustive studies of the several districts have been made.

GEOGRAPHIC AND GEOLOGIC DISTRIBUTION OF METALLIFEROUS LODES.

INTRODUCTION.

The distribution of the metalliferous lodes in Alaska is indicated on the accompanying map (Pl. I, in pocket), on which the localities of metal deposits are indicated by symbols. It would undoubtedly add much value to this paper if the distribution of the metals could have been shown on a geologic map, but such a map was not practical in this report, intended for early publication, because of the time needed both to compile the geologic data and to publish a map in colors. The larger features of the areal geology of some of the more important parts of the Territory are represented on Plates II, III, and IV, which will be supplemented by brief verbal descriptions of the geology of the entire province.

The general map (Pl. I) strikingly illustrates the very wide distribution of gold in the Territory. It will be shown that the gold is so widespread because the conditions for its deposition in the bedrock existed over large areas during Mesozoic time, rather than because there are many types of auriferous deposits or because they were formed during many epochs of geologic history. Copper, too, occurs in several widely separated districts, but there is less uniformity in the form of its occurrence than in that of the gold deposits.

The copper deposits are probably also chiefly of Mesozoic age. The tin deposits are practically all limited to one district and to one general epoch of formation.

The marked parallelism of the larger bedrock structures which prevails throughout much of Alaska has had a wide influence on the areal distribution of many of the stratigraphic subdivisions, and hence on the mineral deposits associated with them. These structures parallel the Pacific seaboard of Alaska, trending northwestward to about the one hundred and forty-ninth meridian, thence swinging to the west and southwest. As the position of the dominant mountain ranges and systems has been determined by these structures, their axes have the same trends.

The structures above noted have determined to a large extent the areal distribution of the bedrock formations, especially of those older than Upper Cretaceous. As a result of these tectonic lines, many of the geologic subdivisions occur in belts which parallel the Pacific seaboard. As it is impossible to present here a complete summary of the geology of Alaska, its larger features can probably best be elucidated by describing briefly the successive zones of rocks, similar in general lithology or age, which form the larger stratigraphic units, together with the metal deposits associated with them. These formations or zones will be described, so far as possible, in their geographic sequence from south to north. The order of treatment will have to be modified to a certain extent and some of the local geology will be presented by provinces, defined by drainage basins.

PACIFIC COAST REGION.

Four large stratigraphic units have been recognized in southeastern Alaska (see Pl. II). (1) A series of Paleozoic sediments locally interbedded with greenstones, including terranes varying in age from Silurian to Carboniferous and in places highly metamorphosed. The recent investigations of Knopf in the Juneau district show that locally, at least, Mesozoic sediments are closely infolded with some of these Paleozoic rocks and that some of these are highly metamorphosed. (2) A series of Mesozoic sediments (Lower Cretaceous or Jurassic) made up largely of clastic material. (3) The great batholiths of the Coast Range, comprising intrusive rocks varying in composition from granite to diorite and later than Middle Jurassic in age. Intrusive rocks of this age and composition are also widely distributed in isolated stocks or dikes. (4) Some small areas of Tertiary (Eocene) sediments and lavas.[1] In general, all these rock groups can be said to occur in a series of belts which are parallel to the northwest-southeast trend of the coast line. On the east the province is bounded by a broad belt of granitic intrusive rocks,

[1] There are also some recent lavas, which will not here be considered.

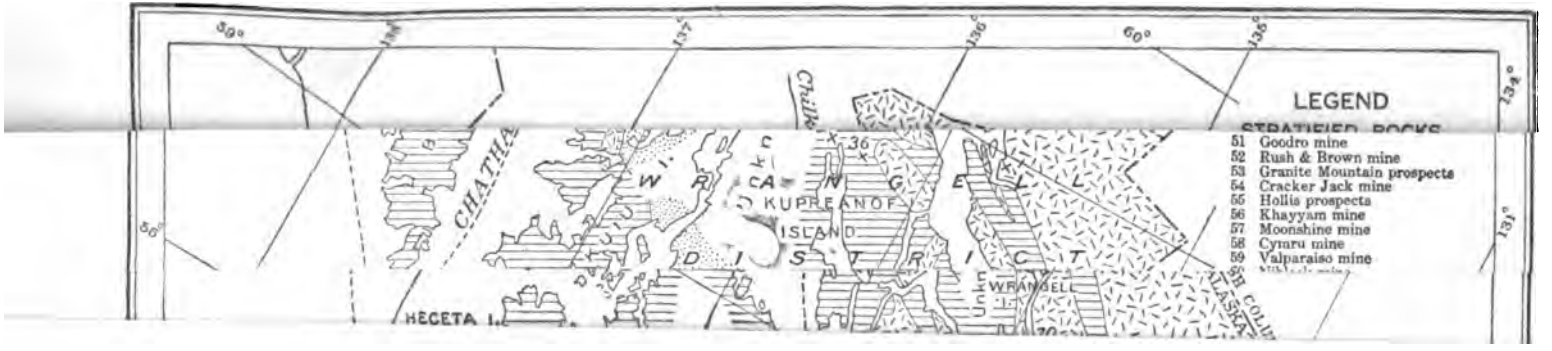
forming the Coast Range. Adjacent to these intrusive rocks on the west is a series of deformed Paleozoic and Mesozoic sediments. In most places a belt of metamorphosed sediments lies immediately adjacent to the granites of the Coast Range. A less altered series of Mesozoic or Paleozoic rocks lies next to the west. These have been locally metamorphosed by intrusive rocks lithologically similar to those of the Coast Range. The Mesozoic rocks occur in several broken belts within the areas of Paleozoic formations. One of the largest known of these belts skirts the westernmost islands of the Alexander Archipelago in the vicinity of Sitka.

The best-developed and largest known auriferous ore bodies of the Territory occur in a belt of Mesozoic and Paleozoic sediments (see Pl. II) skirting the mainland of southeastern Alaska and usually separated from the granitic batholiths of the Coast Range by a zone of crystalline schists a mile or more in width. Within this general zone of mineralization is included the Juneau gold belt, from which most of the lode gold of Alaska has been produced. This is a well-defined belt of mineralization from Snettisham on the south to Berners Bay on the north; but some gold has been found in both the northern and southern extensions of this belt.

In addition to the deposits occurring in this zone, auriferous quartz veins have also been found in or near the marginal zones of some of the outlying intrusive masses occurring in different parts of the Alexander Archipelago. Noteworthy examples of these auriferous lodes are those found in the slates and graywackes, probably of Mesozoic age, of the Sitka region. These rocks do not seem to have been metamorphosed by granitic intrusions, which are, however, not far distant. In southeastern Alaska auriferous deposits are also found within the intrusive masses themselves.

The Ketchikan district contains some important copper deposits. Of these, the best-known type is that which occurs in the contact zones of Paleozoic limestones and intrusive rocks, but there are also other types.

An extension of the strike lines of the formations of southeastern Alaska will carry them into the unexplored heart of the St. Elias Range. At Yakutat Bay two groups of rocks have been recognized. The eastern group, which probably forms the bedrock of the high ranges, is made up of crystalline and semicrystalline altered sediments, probably chiefly Paleozoic, with many intrusive rocks. The western, called the Yakutat group, consists of very highly contorted sediments, with some greenstones and other rocks, which have been provisionally referred to the Mesozoic. Little is known of the metalliferous resources of this district; but the fact that the glacial gravels derived from the St. Elias Range are locally more or less auriferous makes it probable that some gold-bearing quartz veins occur in the mountains.


LEGEND
51 Goodro mine
52 Rush & Brown mine
53 Granite Mountain prospects
54 Cracker Jack mine
55 Hollis prospects
56 Khayyam mine
57 Moonshine mine
58 Cymru mine
59 Valparaiso mine
CHATHAM
HECETA I.
KUPREANOF ISLAND
WRANGELL
WRANGELL DISTRICT
ALASKA
60°
59°
134°
131°

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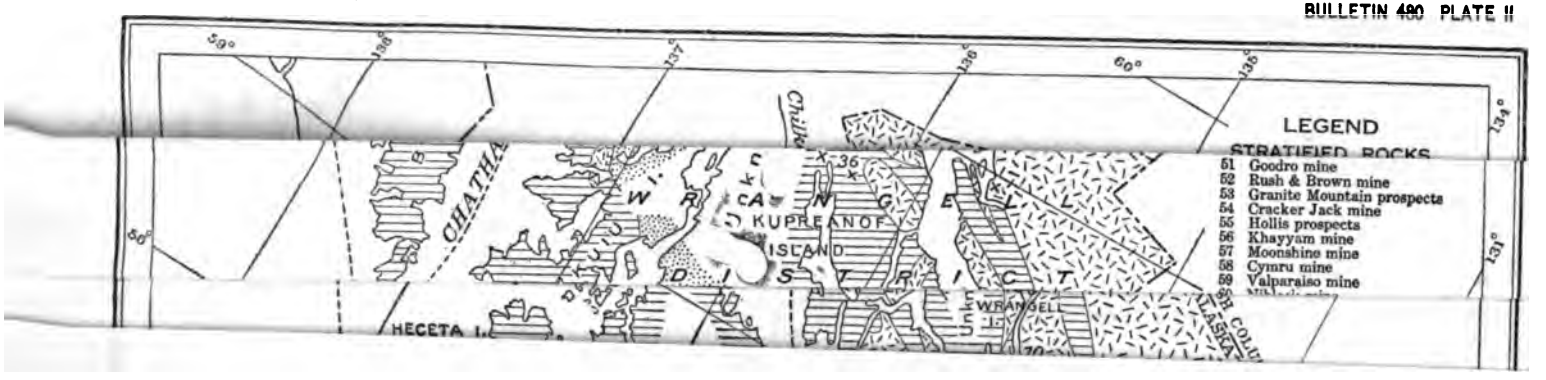

59°
138°
137°
136°
60°
135°
134°
131°
CHATHA
W R
CA N G E
KUPREANOF
ISLAND
D I S T R I C T
HECETA I.
WRANGELL
LEGEND
STRATIFIED ROCKS
51 Goodro mine
52 Rush & Brown mine
53 Granite Mountain prospects
54 Cracker Jack mine
55 Hollis prospects
56 Khayyam mine
57 Moonshine mine
58 Cymru mine
59 Valparaiso mine

On tracing the coast line westward, metamorphic rocks of unknown age are found at Controller Bay, but are not known to carry any metalliferous deposits. These rocks are unconformably overlain by a closely folded sequence of Tertiary age bearing bituminous and anthracite coal.

Still farther west, on Prince William Sound, there is an older (probably Paleozoic) series of more or less altered sediments (Valdez group) overlain by a series of sediments and ancient lavas (Orca group), which are probably of Mesozoic age. Both series are closely folded and are locally cut by granitic intrusive rocks. The Chugach Mountains, which form the coastal barrier north of Controller Bay and Prince William Sound, so far as known, are made up of closely folded sediments, probably belonging to the same two groups of formations, and these are locally auriferous. In the western part of Prince William Sound the bedrock formations swing to the southwest, and the same groups of metamorphic sediments occur in the eastern part of Kenai Peninsula. These are succeeded near Kachemak Bay, on the southwestern part of the peninsula, by Mesozoic beds. Most of the western half of Kenai Peninsula is covered by little-disturbed Tertiary lignitic coal-bearing rocks and by Quaternary gravels. The geology of Kodiak Island is little known, but it is probable that metamorphic sediments of the same age as those of Kenai Peninsula form the dominating country rock, with small scattered areas of Tertiary lignite-bearing sediments.

On Prince William Sound cupriferous deposits have been found in association with the greenstones and sediments of the Orca group. Deposits of similar types occur near Resurrection Bay, an indentation of the northeastern part of Kenai Peninsula, and are reported from Kodiak Island. Auriferous quartz veins have been found at a number of places on Prince William Sound, occurring in slates and graywackes of both the Orca and Valdez groups. Similar types of occurrence are found in Kenai Peninsula in what is probably the extension of the same groups of sediments. Some gold deposits have also been found on Kodiak Island. None of these deposits are known to have such marked association with intrusive rocks as has been noted in the metalliferous veins of southeastern Alaska.

That part of the Iliamna region which lies adjacent to Cook Inlet is occupied chiefly by sediments and volcanic rocks of Mesozoic age, which are thrown into broad open folds. On the west the Mesozoic is bounded by a broad belt of granitic rocks locally altered to gneisses and probably intruded chiefly in Jurassic time. Within the granite area are some small belts of metamorphic greenstones, limestones, slates, and cherts, which may be Paleozoic but whose age is undetermined. Volcanic rocks and sediments, chiefly of Mesozoic age, lie

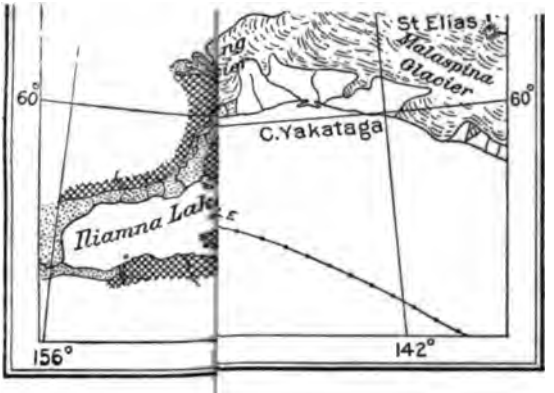
adjacent to the granite on the west. These form the country rock of much of the shores of Iliamna and Clark lakes. In this field there are also some very extensive Tertiary and recent volcanic rocks. In the Iliamna region there are some auriferous and cupriferous ore bodies which occur chiefly in the altered sediments of Paleozoic or younger age at and near the contact of intrusive rocks. Some placer gold has been found in the Mulchatna basin, lying west of Lake Clark, but its geologic association is not known.

Mezozoic and Tertiary sediments and volcanic rocks, so far as known, form the country rock of much the larger part of the Alaska Peninsula and adjacent islands. The typical structures seem to be open folds with considerable faulting. Granitic intrusive rocks have not been found in that part of the Alaska Peninsula which has been examined, and there is but little evidence of metallization. The Aleutian Islands are unsurveyed and geologically almost unknown. It seems probable, however, that they are largely built up of volcanic rocks, of which a part are certainly recent, some may be of Tertiary age, and some are as old as the Mesozoic. Some intrusive granite stocks occur in this province.

The developed metalliferous deposits of southwestern Alaska are confined to Unga and Popof islands, where auriferous veins occur in lavas, probably of Mesozoic age. Some auriferous mineralization is, however, known at other localities, notably on Unalaska Island, where it is found in volcanic rocks (probably Mesozoic) near the contact with an intrusive stock of granite.

COPPER RIVER REGION.

The Chugach Mountains, which bound the Copper River basin on the south, are made up of closely folded sediments, more or less altered and intruded by igneous rocks, and carry some auriferous deposits. The broad alluvium-filled Chitina Valley, between the Chugach Mountains on the south and the Wrangell Mountains on the north, separates two provinces whose geology is quite different. (See Pl. III.) The Wrangell Mountains are probably formed by a broad syncline or synclinorium. Along the south arm of this syncline the sequence consists of a series of ancient volcanic rocks (Carboniferous or Triassic), called the Nikolai greenstone, succeeded conformably by the Chitistone limestone (Triassic), and this in turn by several formations of Mesozoic sediments capped by a great complex of volcanic rocks, which are in part recent and in part may be Tertiary. The north arm of the syncline, as exposed in the upper basins of White, Chitina, and Nabesna rivers, shows Carboniferous limestones and greenstones, succeeded by Mesozoic beds, and these in turn by the recent volcanic rocks. Mesozoic intrusive rocks are fairly abundant in these formations. The direct correlation of the older beds on the two arms of the syncline has not been possible with the


St Elias
Malaspina
Glacier
60°
60°
C. Yakataga
Iliamna Lake
156°
142°

information at hand. On the west the Wrangell Mountains fall off to the broad gravel-filled basin which stretches from the Copper to the Susitna basin.

The best-developed ore deposits of this region are the copper-bearing lodes occurring along the southern flank of the Wrangell Mountains and chiefly in the basins of Kotsina and Chitina rivers, which are tributary to the lower Copper. These deposits occur in the Nikolai greenstone and Chitistone limestone, principally near the contact of the two formations. (See Pl. VI.) Copper occurs also on the northern flank of the Wrangell Mountains, in the basins of White River and of tributaries of the Tanana, where the associated sediments are, however, probably chiefly Paleozoic, and some of these deposits are along contact zones of intrusive diorite. The gold of the Nizina placers, in the upper Chitina basin, has been derived from quartz veins occurring in Upper Jurassic sediments near contacts with quartz diorite intrusive rocks.

North of the Wrangell Mountains lies a belt of closely folded Mesozoic sediments which constitute the Nutzotin Mountains. To the west these mountains merge with the Alaska Range, but there appears to be a marked change in their component strata. In the basin of the Chistochina the foothills of the Alaska Range are made up of upper Paleozoic sediments and volcanic rocks, with later intrusives. This series is separated by a great fault from a belt of metamorphic schists which constitute the greater part of the mountains to the north. On tracing these mountains westward, the geology is again found to change. In the upper Susitna basin the southern mountain front is made up of Mesozoic slates and greenstones of undetermined age which have been invaded by large masses of granitic rocks. In the heart of the range, however, the metamorphic schists are believed to dominate.

The gold of the Chistochina placers, in the northern part of the Copper River basin, appears to have been derived from quartz veins in Carboniferous sediments in a contact zone of intrusive granodiorites. No lode deposits have been developed in this field, but in the Nabesna basin, 60 miles to the east, some work has been done on a lode which appears to be a mineralized zone between a granodiorite and contact-metamorphosed limestone. The Valdez Creek placers have derived their gold from slates which are probably of Mesozoic age. These slates, like those of the Juneau gold belt, are separated from the granitic intrusive rocks by a zone of highly metamorphosed sediments.

SUSITNA AND MATANUSKA BASINS.

The region lying north of Cook Inlet falls into two general geologic provinces, separated by the Susitna Valley. (See Pl. III.) On the east are the Talkeetna Mountains, made up largely of granitic intrusive

rocks believed to be chiefly of Mesozoic age, with a marginal zone of metamorphic sediments. Along the southern flanks of these mountains, drained by Matanuska River, Eocene coal-bearing beds and Jurassic and Cretaceous sediments and volcanic rocks, with possibly some Paleozoic sediments, have been found. These formations, where they lie against the granite, are intensely deformed and faulted. Toward the central part of the Matanuska Valley, however, the Tertiary beds and associated Mesozoic sediments are less disturbed but are cut by many intrusive rocks. Some Tertiary (post-Eocene) volcanic rocks are also found in this province. The metamorphic sediments of the Chugach Mountains, already described, form the southern boundary of the Matanuska Valley.

The geology of the region north of the Talkeetna Mountains is but little known. The bedrock appears to be in part metamorphic sediments, in part little-altered Mesozoic sediments and volcanic rocks.

Some auriferous deposits have been found along the margins of the Talkeetna intrusive rocks. Those developed include the gold placers and lodes of the Willow Creek district. (See pp. 139–152.) Copper deposits are also reported in this province.

The Alaska Range, which bounds the Cook Inlet depression on the west and north, is made up of Paleozoic and Mesozoic sediments thrown up into a broad synclinorium, along the west limb of which there has been profound thrust faulting. These sediments are cut by many large stocks of granite and some of more basic rocks. Though the granitic rocks are of the same type and age as those of the Talkeetna Mountains, they differ in appearing to have brought about but little contact metamorphism. A series of closely folded slates, provisionally assigned to the Paleozoic, occurs along the eastern foot of the Alaska Range. These are believed to form the bedrock of the Yentna placer district, and the occurrence near by of large intrusive masses of granitic rocks suggests a genesis of the auriferous deposits similar to that described for other parts of the Territory. The slates are succeeded by a great complex of Jurassic volcanic rocks, with some sediments (Skwentna group), which are locally auriferous, though they have not yet yielded any commercial deposits. Jurassic slates and graywackes (Tordrillo formation) rest on the volcanic rocks unconformably. Some auriferous mineralization is reported to occur along the contact zones of these slates and the granitic intrusive. The Jurassic sediments have also been recognized along the west arm of the syncline, but here the volcanic rocks (Skwentna group) are absent and the Jurassic sediments rest unconformably on Paleozoic sediments made up of Ordovician, Devonian, and possibly Silurian (Tatina and Tonzona groups) and Carboniferous (?) (Cantwell formation). Some little-disturbed Tertiary coal beds occur along the eastern margin of the range. Tertiary beds are

also involved in the profound dislocations along the western base of the range. The Mesozoic beds which form the central part of the synclinorium in the southwestern part of the range do not extend through to the Broad Pass region, where there appear to be only Paleozoic rocks. To the east along the range the recognizable Paleozoic sediments appear also to die out, for the main range in the Valdez Creek region, as already stated, seems to be made up largely of metamorphic schists (Birch Creek?) and granites. The western extension of this schist passes north of the main range in the Nenana basin and here appears to be auriferous, for it forms the bedrock of the Kantishna placer district.

YUKON AND KUSKOKWIM BASINS.

A series of highly metamorphosed sediments of great thickness, called the Birch Creek schist, forms the oldest rocks of the Yukon basin and is probably of pre-Ordovician age. This series is typically made up of quartz-mica schists and mica schists. A common phase is a micaceous quartzite. It also includes crystalline limestones and some greenstone schists which are altered igneous rocks. Gneissoid granites are extensively developed here and there in the schist areas.

The Birch Creek schist is typically developed in the Yukon-Tanana region, where it occupies a broad belt striking westward from the international boundary through to Fairbanks, on Tanana River, forming the country rock of the important placer fields of this province. (See Pl. IV.) North of the Yukon a second belt of schists, of a similar type and probably of the same age, extends westward from the Chandalar placer and lode district into the Koyukuk placer district. Another belt of schists about which little is known but which are probably of the same age occurs in the Kaiyuh Mountains. These mountains lie between the lower Yukon and Innoko districts, which are known to be auriferous, though no commerical placers have been found in this region as yet. This belt probably crosses the Yukon above the mouth of Melozitna River and stretches through the unsurveyed area lying between the Yukon and the Koyukuk. In Fairbanks and Chandalar, as well as in other districts, auriferous quartz veins have been found in the Birch Creek schist. The auriferous mineralization, both in the lode and placer districts, seems to be closely related to granitic intrusive rocks. The age of these granites is probably Mesozoic and is known to be in part Upper Cretaceous.

In the Yukon-Tanana region the Birch Creek schist is succeeded unconformably by many thousands of feet of Paleozoic sediments ranging in age from Ordovician to late Carboniferous. It is beyond the scope of this paper to describe in detail the formations which go to make up this great sequence. Before Upper Devonian time there was a period of diastrophism which deformed the beds

previously deposited, and these older formations are known to be locally mineralized and to form the source of some of the placer gold. These older beds are also developed in other parts of the Yukon region and adjacent portions of the Kuskokwim basin.

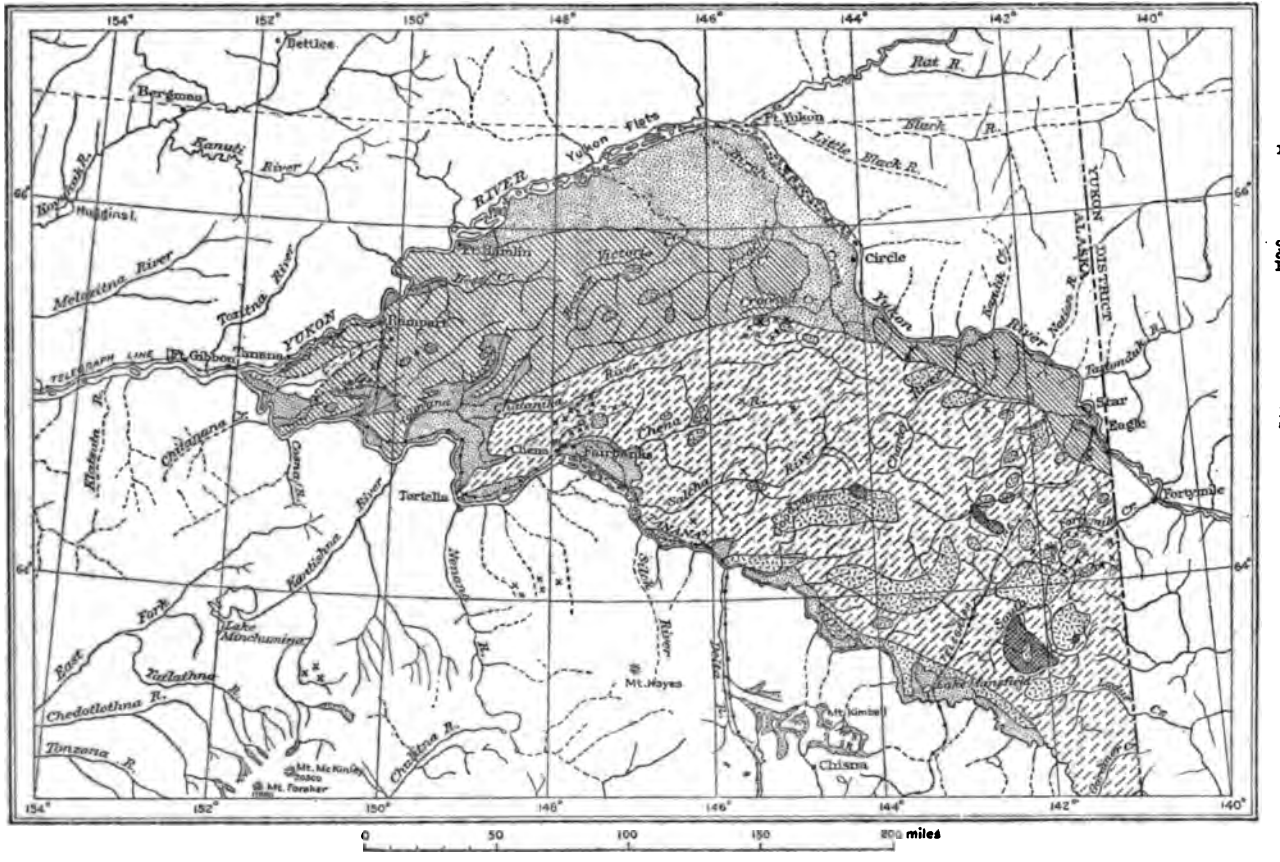
The Mesozoic is represented in the Yukon region by some Triassic limestone and in the Yukon and Kuskokwim basins by widely distributed clastic rocks with some volcanic rocks of Lower Cretaceous or Jurassic age. These rocks are especially well developed in the lower Yukon, Koyukuk, and Kuskokwim valleys and in the Norton Bay region. In the Yukon-Tanana region these Jurassic or Cretaceous rocks do not seem to be loci of important ore deposits, though they are known to be locally mineralized. On the other hand, the gold of the placers of the Innoko-Iditarod region seems to have been derived from contact zones of these Mesozoic sediments and intrusive granites. (See pp. 243–246.) The same is probably true of the Bonanza Creek placers, on Norton Bay.

The only other hard-rock formations of this province are the Eocene and Upper Cretaceous strata, carrying lignitic and subbituminous coal. These beds appear to be widely distributed but do not occur in any large areas. As a rule they do not seem to be metallized, but in the Rampart region some Upper Cretaceous beds have been found which are cut by granite, and near the contact there are some small pyritized quartz veins.

SEWARD PENINSULA.

The Mesozoic sediments stretch westward from the lower Yukon until they lap over on the Paleozoic and older rocks of Seward Peninsula. These Paleozoic rocks constitute a series of varied composition, ranging in age from Cambrian to Carboniferous. They appear to rest on an older series, made up of schists and crystalline limestone and called the Kigluaik group, which may be of pre-Paleozoic age. Granitic stocks have been found in this older group, as well as cutting limestones as young as Carboniferous. There are also some schists, which are altered igneous rocks, infolded with the sediments of different ages. In the northeastern part of the peninsula Mesozoic or Tertiary volcanic rocks are extensively developed. A few small areas of Mesozoic or Tertiary lignitic coal-bearing rocks also occur on Seward Peninsula, as well as Quaternary lava flows.

The placer gold of Seward Peninsula appears to have been derived largely from contact zones of Paleozoic limestones and schists. There are also known occurrences of auriferous mineralization in slates and quartzites. In neither case can the mineralization be directly traced to the influence of intrusive rocks. The peninsula contains, however, some tin deposits, which are directly associated with granite stocks intruded in the Paleozoic sediments.



LEGEND

- Alluvial deposits
- Paleozoic with areas of Mesozoic and Cenozoic
- Pre-Ordovician, chiefly schists with undetermined areas of Paleozoic and igneous rocks
- Fresh volcanics (post-Tertiary?)
- Intrusives, part fresh and part metamorphosed
- Gold placers

GEOLOGIC SKETCH MAP OF YUKON-TANANA REGION.

By L. M. Prindle, 1907

NORTHERN ALASKA.

The geology of northern Alaska is but imperfectly known. On the Kobuk have been found metamorphic sediments, probably representing the same horizons as those of Seward Peninsula, which are, locally at least, auriferous. (See pp. 271–319.) There are also large areas of folded Mesozoic sediments that probably represent the same horizons as those of the lower Yukon.

Near Cape Lisburne occur Carboniferous limestones carrying high-grade coal, some clastic rocks provisionally referred to the Devonian, and a great thickness of folded Jurassic beds, which carry extensive deposits of subbituminous coal. Tertiary beds are also known to occur in this province.

In the section exposed along the Colville and its tributaries Schrader found a central area occupied by rocks of varied lithology and unknown age. South of these are the metamorphic schists of the Koyukuk basin, already described, and to the north are some closely folded and faulted Carboniferous limestones (Lisburne formation) and a heavy conglomerate and slate series of unknown age. North of the mountains these Paleozoic rocks pass underneath gently folded Mesozoic sediments, and these, in turn, under Eocene sediments. Throughout this section there is a striking absence of intrusive and volcanic rocks, and no metal deposits have been found. It is reported by prospectors that crystalline schists occur to the east, near the international boundary, and that some placer gold has been found there.

OUTLINE OF GEOLOGIC HISTORY.

INTRODUCTION.

What is known of the areal distribution of the larger stratigraphic units and their associated metals has been briefly presented in the foregoing pages. In this section will be given an outline of some of the more important events of geologic history which have produced these deposits. Many of these events will be very briefly touched upon, as they have only an indirect bearing on the subject considered, but special emphasis will be laid on those occurrences of the geologic past which are believed to have contributed directly to the formation of ore bodies. It will be impracticable to attempt to correlate all the events of the geologic history of different parts of the Territory; therefore the history will to a certain extent be recounted by districts, taken in order from south to north.

PRE-PALEOZOIC AND PALEOZOIC TIME.

Pacific seaboard.—A number of stratigraphic units, made up chiefly of limestones, cherts, and slates and ranging in age from Silurian to

Carboniferous, have been recognized in the Paleozoic rocks of southeastern Alaska. These represent periods of deposition which were probably interrupted by folding and erosion but need not here be considered in detail. In late Carboniferous or early Triassic time there were in this province extensive extravasations of the basic eruptive rocks, which are now found interbedded with sediments. The metallization all seems to have taken place in post-Paleozoic time.

The broad belt of more or less metamorphosed sediments which skirts the Pacific seaboard from St. Elias westward to Kenai Peninsula (Valdez group) is probably of Paleozoic age or includes some Paleozoic rocks, but the Paleozoic history of this belt is obscure and need not be considered here, as the metal deposits of these rocks are probably of post-Paleozoic age.

Copper-Susitna region.—Records of Paleozoic sedimentation in the Copper-Susitna region are exceedingly meager, for only rocks of Carboniferous age have been definitely recognized. These are chiefly limestones or volcanic rocks, and there is no evidence that they were deformed, intruded, or metallized in pre-Mesozoic time. On the inland slope of the Alaska Range many thousands of feet of Paleozoic rocks were deposited. These have been divided into four groups, ranging in age from Ordovician to Carboniferous. Sedimentation was interrupted by several epochs of folding, followed by erosion. None of these rocks show evidence of mineralization in Paleozoic time, and their earlier geologic history is therefore not pertinent to this discussion.

Yukon and Kuskokwim basins.—Little is known of the sequence of events by which the Birch Creek schist—the oldest formation of the Yukon basin—was formed, but it consists certainly for the most part of sediments deposited in early Paleozoic or pre-Paleozoic time. After the deposition and induration of these sediments they were invaded by igneous rocks of various types and still later, but probably in pre-Ordovician time, they were intensely deformed while under a heavy rock cover. Before this deformation and possibly accompanying or immediately after the igneous intrusions, quartz veins were injected, some of which appear to have been metalliferous. These veins were folded and broken by the subsequent deformation and now occur chiefly as stringers, thin lenses, and vugs, which constitute the oldest system of veining in the region and do not seem to be of economic importance. Uplift and a long period of erosion of this complex seem to have taken place before the deposition of the oldest known Paleozoic formation of this field, which has been assigned to the Ordovician. The important auriferous mineralization of the Birch Creek schist, as will be shown below, is believed to have taken place in Mesozoic time.

The sequence of geologic events in the Yukon region during Paleozoic time up to the Middle Devonian is far from being established. It is known that there were long periods of deposition interrupted by epochs of erosion, and the resulting strata have been divided into several rock groups, including some which are known to be Ordovician, some Silurian, and some probably Lower Devonian. There appears to have been no notable metallization of these rocks during these periods of diastrophism. The Middle Devonian is characterized by a siliceous limestone which is very widely distributed in Alaska and which in the Yukon-Tanana region is associated with a great thickness of volcanic rocks, chiefly of a basic character, which at a later time were locally mineralized.

It is probable that after the deposition of the Middle Devonian beds there were extensive crustal disturbances, and these may have been accompanied by some quartz veining. The later Paleozoic history of the Yukon is of no significance to the problems here under discussion, and it will suffice to state that in Upper Devonian and Carboniferous time there were two periods of erosion, but that there appears to have been no interruption to sedimentation from Paleozoic to early Mesozoic time.

Seward Peninsula.—A Cambrian limestone is the lowest formation in Seward Peninsula whose age has been determined, but some schists and limestones have been found that may be older. In general, the known Paleozoic of the peninsula is represented by vast thicknesses of limestones ranging in age from Upper Cambrian to Carboniferous. Intercalated with some of these are schists which are in part known to be of igneous origin and various clastic rocks. The whole sequence has been so intensely deformed as to defy subdivision except after most detailed investigation.

An injection of quartz veins took place previous to this deformation, and these are now found as small irregular lenses and stringers. Many of these veins are metallized and some are said to be gold bearing. It is an open question whether the placer gold was derived to any extent from the older system of veining, or whether its source is largely in the younger unsheared veins referred to below. This latter epoch of auriferous mineralization is provisionally assigned to the Mesozoic, as is also the mineralization which produced the deposits of cassiterite, galena, etc., which are all more or less intimately associated with granites that are probably of post-Carboniferous age.

Northern Alaska.—Paleozoic rocks, in part of Carboniferous age, occur in the Endicott Mountains of northern Alaska, but the sequence of geologic events in this region has not been definitely determined. A series of schists, probably of Birch Creek age, occurs along the northern base of the Endicott Mountains, and probably has had the same geologic history. Similar rocks occur in the Kobuk Valley. The

fact that there appears to have been no intrusion of igneous rocks or of metallized quartz veins in the Paleozoic areas of the Endicott Mountains is for the present discussion the most noteworthy fact in the geologic history of this region.

MESOZOIC TIME.

Economic importance.—From the standpoint of one interested in ore deposits, the Mesozoic was the most important era in the geologic history of Alaska, for nearly all the metallization which has formed commercial deposits and to which age assignment can be made falls within it. The time of most intense and widespread metallization can probably be still further limited to the Jurassic or Cretaceous and was thus synchronous with the mineralization which produced the valuable deposits of California and other parts of the western Cordillera. Therefore most of Alaska's metallic deposits belong to the same metallogenetic province as those of the western United States. It is not to be understood by this that the ore deposits are in any sense confined to Mesozoic horizons, for this is far from being the case. In fact, except in southeastern Alaska and in a few other districts the metalliferous deposits occur chiefly in pre-Mesozoic rocks. The mineralization which caused ore deposits took place, however, in Mesozoic time.

Stratigraphic sequence.—Sedimentary and volcanic rocks of Triassic age are widely distributed in Alaska. In general the Triassic appears to have been a period of limestone deposition, with possibly some local volcanic outbursts. So far as known, there are only a few localities where ore deposits occur with Triassic rocks. The most noteworthy of these are in the Copper River region, where copper deposits occur in the Chitistone limestone, of Triassic age, and in an older series of ancient lava flows (Nikolai greenstone), of either Triassic or Paleozoic age.

The Orca group, of Prince William Sound, is perhaps Triassic, but it is not possible now to speak with precision in regard to its age. It can be subdivided into a lower member, in which ancient volcanic rocks dominate, with some clastic rocks, and an upper member, in which slates and graywackes dominate, with some volcanic rocks. The lithology of these rocks is very different from that of the Triassic rocks of other parts of Alaska, where calcareous deposits are the rule and the clastic and volcanic rocks are the exception. Sedimentation was closed at about the end of Triassic time by a widespread crustal movement, followed by erosion.

During Jurassic time deposition of fragmental material took place over much of Alaska. Many thousands of feet of sandstones and argillites, with some volcanic rocks, were laid down, and sedimentation was probably interrupted by periods of erosion. The Jurassic history is complex and need not be considered for the purposes of

this report. One phase of it which deserves mention, however, is the volcanic outburst in the southwestern part of the Alaska Range and in the Alaska Peninsula. The rocks of this epoch are locally auriferous, though they have not yet been the source of any large amount of gold. In late Jurassic and early Cretaceous time extensive deposits of argillaceous and arenaceous sediments were accumulated over much of Alaska, and these were subsequently folded and more or less altered. These Jurassic and Cretaceous sediments are important loci of gold deposits in southeastern Alaska and elsewhere. They appear to form the youngest beds which have yielded any commercial ore bodies, though some evidence of mineralization has been found in rocks as young as the Upper Cretaceous.

Intrusive rocks.—The genesis of most of the Alaskan ore bodies is more or less directly traceable to the influence of intrusions which took place during Mesozoic time. During this period of intrusion probably most of Alaska south of the Endicott Mountains was injected by igneous rocks. The intrusions began in early Jurassic time, possibly in some parts of the region in Triassic or even in late Paleozoic time, and culminated during Lower Cretaceous time, but continued in some places into the Upper Cretaceous. This epoch of volcanism followed and accompanied crustal movements which were continental in their effect and as a result of which many of the main structural lines were established. Along these lines, however, some movements took place later.

The great batholiths of the Coast Range of southeastern Alaska were probably intruded during Jurassic and Cretaceous time. The northwesterly extension of this same belt of intrusive rocks carries them into the Alaska Range, where large stocks of igneous rocks are common. All these intrusive rocks show the same lithologic facies, ranging from granites to diorites in composition. Rocks of the same varieties and of approximately the same age of intrusion are found in the batholiths of the Talkeetna Mountains, north of Cook Inlet. Granitic rocks are abundantly developed in the Iliamna region, some of which, however, may be of Paleozoic age. Mesozoic granitic intrusive rocks are also found in the lower Yukon and Kuskokwim basins and in the Norton Bay region. The age of the granites of Seward Peninsula is unknown, but they are, in part at least, later than rocks known to be of Mississippian age and are probably Mesozoic. It is impossible to speak with precision as to the age of the granitic rocks of the upper Yukon basin. At one locality they cut Upper Cretaceous rocks, and the presumption is fair that they are in greater part of Mesozoic age and to be correlated with those of the other parts of Alaska whose age has been more definitely fixed.

In addition to the granular intrusive rocks, dikes of similar chemical composition but differing mineralogically occur in many parts

of Alaska and seem to belong to the same period of intrusion. This period of intrusion was probably long continued in some parts of the province, where there were probably several series of intrusions, the later ones being injected after the first had been solidified and fractured. Thus, in southeastern Alaska the main granitic masses were fractured and injected by acidic aplitic dikes, which represent the last phase of this epoch of volcanism. Similarly, the metalliferous quartz veins were introduced after the igneous intrusives—in fact, after these were solidified and fractured. The genesis of the quartz veins is therefore probably related closely to that of the granite.

The wide distribution of the metalliferous deposits in the contact zones of the igneous and country rock has already been pointed out. The gold and copper deposits of southeastern Alaska and of the Iliamna region, the gold deposits of the Nizina, Yukon-Tanana, Chistochina, Yentna, Willow Creek, Koyukuk-Chandalar, Innoko-Iditarod, and possibly those of Prince William Sound and Kenai Peninsula, all appear to be genetically related to the Mesozoic intrusive rocks. In fact, the auriferous deposits of Seward Peninsula are the only ones for which there does not seem to be some rather clear evidence that their mineralization is genetically related to igneous rocks, and in most of the auriferous districts there is good reason to believe that the intrusions took place in Mesozoic time.

TERTIARY AND QUATERNARY TIME.

The geologic history of Tertiary and later time bears only indirectly on the occurrence of metalliferous lodes. The Eocene was essentially an epoch of lacustrine and fluviatile conditions, when extensive deposits of coal accumulated. This was followed by a period of diastrophism, in which most of the folding of the rock strata now visible took place and was accompanied by some basic intrusion and extravasation of volcanic rocks. So far as known, there was no mineralization during this period of deformation. It is, however, important in the consideration of the distribution of the metals, because it determined in many districts the attitude and areal distribution of the beds with which the metals are associated.

Late Tertiary and Quaternary history is replete with geologic interest but has little bearing on the present discussion. Its later phases had to do with the accumulation of the alluvium in which the gold placers occur. In the Quaternary, too, occurred an epoch of glaciation which removed from the mountains of the coastal system, and to a less extent from those of northern Alaska, the débris resulting from the previous weathering, and in some places deeply channeled the drainage courses. This phase of the geologic history has one important bearing on the lode mining, inasmuch as the glacial ice, in part at least, removed the upper zone of rock material in which

the secondarily enriched mineral deposits should be found. It is probably safe to conclude that in most places where glacial scouring was active no deposits which have been secondarily enriched by surface waters occur;[1] in any event, no such deposits have yet been recognized in Alaska except at very shallow depths.

THE ORE DEPOSITS.

INTRODUCTION.

For the purpose of systematic description the lode deposits will be thrown into several large groups, each of which will be made to include all the deposits chiefly valuable for a certain metal. Within each group further subdivisions will be made, based primarily on geologic association and only secondarily on considerations of mineralogy and genesis. This rough classification will, it is believed, serve the present purposes and will accord with the limitations placed on this discussion, both as to length and as to precision of data used. It will, at least, have the merit of making no pretense at anything except immediate utility and will leave a clear field for the formulating of a genetic scheme of classification by those who have made a more exhausitve study of the subject than the writer has.

GOLD.

OUTLINE.

The gold-bearing lodes which are more or less closely associated with intrusive rocks form by far the most important group of auriferous deposits in Alaska, and these intrusives are, as has been shown, chiefly if not wholly of Mesozoic age. A second group of gold deposits which for the present will be regarded as distinct, comprises those of Seward Peninsula, for these are not known to have a genetic relation to intrusive rocks. Each of these larger groups can be further subdivided in accordance with the country rock in which they occur and the character of the openings in which they were deposited. Thus, those associated with igneous rocks will be subdivided according as they occur in the intruded or in the intrusive rock. Each of these subdivisions can be further separated into fissure veins, impregnated zones, and stockwork deposits. It will be evident from what follows that there are some mixed types of deposits which it will be difficult to fit into this scheme of classification.

DEPOSITS ASSOCIATED WITH INTRUSIVE ROCKS.

GENERAL STATEMENT.

The auriferous deposits of southeastern Alaska, as already pointed out, furnish the best examples of the close association between Mesozoic intrusive rocks and ore bodies. This fact is well illustrated

[1] It will be evident that other factors, such as temperature of water, and hence climate, presence or absence of vegetation, also enter into the problems connected with secondary enrichment, but these will not be considered here.

by the geologic map of this province (Pl. II, p. 46), on which the localities of auriferous ore bodies are indicated. These ore bodies, while they bear a close relation to the intrusive rocks, do not occur in the zone of igneous metamorphism but in the adjacent sediments, which are less highly altered. This seems to be true of all the deposits. In those lodes which lie close to or at the contact of intrusive rocks there is as a rule no great amount of igneous metamorphism.

LODE DEPOSITS IN THE INTRUDED ROCKS.

The best-developed auriferous deposits are those of the Juneau gold belt, which, according to Spencer,[1] occur in a well-defined lode system that skirts the mainland both north and south of Juneau. The country rock is chiefly argillite, with some igneous rocks, which can be collectively classed as greenstones of late Paleozoic or Mesozoic age and lie close to, though not in contact with, the Coast Range batholith.

The dominant ores are those carrying free gold and iron pyrite, but pyrrhotite, chalcopyrite, galena, sphalerite, arsenopyrite, stibnite,

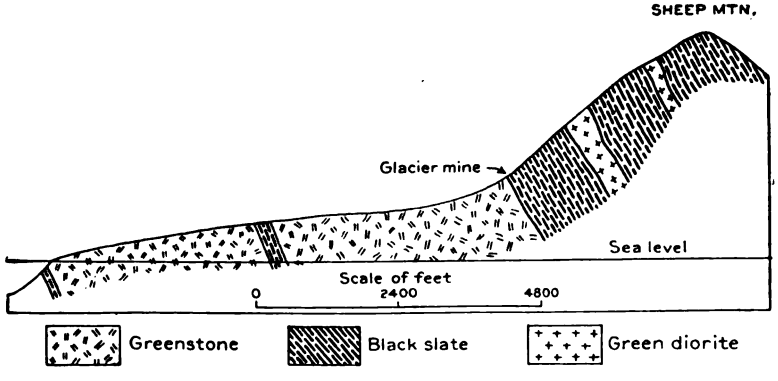


FIGURE 1.—Profile section from mouth of Sheep Creek to Sheep Mountain, Juneau district, showing locus of auriferous mineralization. By A. C. Spencer, 1903.

tetrahedrite, molybdenite, pyrargyrite, and magnetite have also been found. Quartz is the chief gangue mineral, but calcite and other minerals also occur.

Spencer recognizes two types of ore bodies—(1) the veins, which include the mineral aggregates deposited in fractures of the country rock, and (2) the impregnated zones, in which the metallic minerals are disseminated, more or less irregularly, through masses of the country rock. Some deposits, as that of the Treadwell (see pp. 67–69), appear to combine both types of ore bodies. These general types have also been recognized in other parts of Alaska.

A good example of the vein deposits is that on Sheep Creek, near Juneau. Here the country rock is a part of the slate-greenstone

[1] Spencer, A. C., The Juneau gold belt, Alaska: Bull. U. S. Geol. Survey No. 287, 1906, pp. 21-137.

series typical of the Juneau belt, which is cut by diorite dikes. The ore bodies occur at a slate-greenstone contact near the intrusive diorite. In figure 1 the locus of mineralization is indicated by the position of the Glacier mine. At this locality three parallel veins occur in the slates, near the greenstone contact (fig. 2), and these veins, with a number of others lying farther from the greenstone contact, occupy a mineralized zone some 400 feet wide. The fissures are in general parallel to the cleavage, but in places they cut across it.

Across the divide from Sheep Creek, to the northwest, in the valley of Gold Creek, the same general geologic conditions for the occurrence of the ore bodies prevail. The deposits all occur in the greenstone-slate series near contacts with the intrusive rocks. Here the principal mineralization has produced stringer leads which are complex networks of quartz veins following two systems of fractures and constituting a deposit of the impregnated-zone type. Many of these lodes occur directly at the contact of diorite and slate, the diorite being more or less altered.

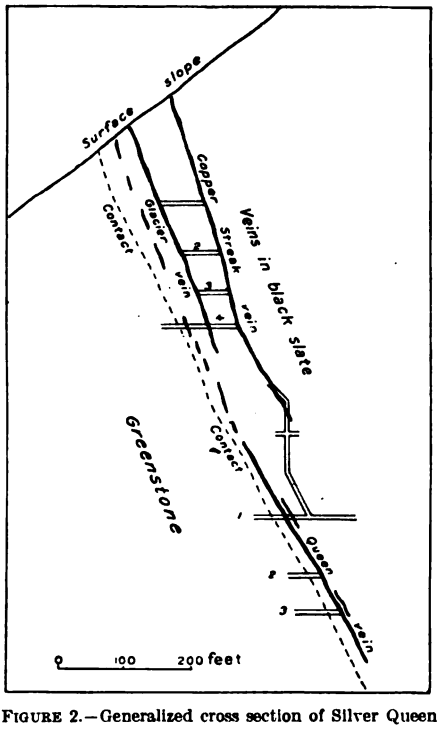


FIGURE 2.—Generalized cross section of Silver Queen and Glacier mines, Juneau district, illustrating the relation of the zone of mineralization to the slate-greenstone contact. By A. C. Spencer, 1903.

In addition to the deposits of the mainland belt some mineralization has been found in the greenstones of the western part of Douglas Island. Here the country rock consists of slates and greenstones and the ore bodies consist of impregnated zones of fracture. Spencer [1] notes that pyrite is the chief metallic mineral in these deposits, but galena, sphalerite, and chalcopyrite have also been found. Albite and rutile occur as gangue minerals.

Auriferous deposits have also been found in the argillite and greenstones which skirt the mainland and adjacent islands west of the granites of the Coast Range in the Ketchikan district, south of Juneau. Here some small fissure veins have been found, but deposits of the disseminated type appear to dominate and have yielded but

[1] Spencer, A. C., The Juneau gold belt: Bull. U. S. Geol. Survey No. 287, 1906, pp. 92-93.

few commercial ore bodies. These deposits occur in rocks which lie adjacent to areas affected by contact metamorphism due to granite intrusion. They include some auriferous quartz veins, but the prevailing type of deposit is the mineralized fracture zone. These zones occur especially in the greenstone schists and are characterized by an abundance of iron pyrite with but little gangue. Their gold values are usually low, but some of them carry lenses and vugs of quartz very rich in free gold.

Deposits of the fissure-vein type have also been found in many parts of the Ketchikan district[1] but so far have yielded no very large or very rich ore bodies. Most of these occur in or are intimately associated with porphyry dikes and will be considered later (pp. 69–70).

The auriferous quartz veins of the Sitka region, described by Mr. Knopf on page 98 of this volume, cut a graywacke series, which is probably of Mesozoic age. No intrusive rocks occur in the immediate vicinity of the ore bodies, but a large stock of granite is known to lie a few miles to the east. Auriferous veins have also been found at a number of places on Prince William Sound,[2] notably at Port Valdez and McKinley Lake. Here again the association with intrusive rocks is not definitely established. On Port Valdez the bedrock consists of a closely folded sequence of slate and graywackes belonging to the Valdez group. The veins appear to follow a well-defined system of fissuring. At the Cliff mine, which is the only deposit examined, the ore is blue quartz carrying much finely disseminated pyrite with minute quantities of arsenopyrite and high values in free gold. Some of the veins have been crushed and recemented by quartz.

The gold-bearing veins of Kenai Peninsula[3] appear to be similar in character. They are quartz veins carrying pyrite, arsenopyrite, and free gold. At one locality some telluride has been found.

Mr. Moffit's description of the Valdez Creek placers (pp. 119–127), in the upper Susitna region, and of the Chistochina placers, both of which occur in argillites, also indicates a close relation between the bedrock source of the gold and the granitic intrusive rocks. To this type of deposit should probably also be added the deposits of Bonanza Creek,[4] near the eastern shore of Norton Bay, where, however, no gold has yet been found in the bedrock.

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[1] Brooks, A. H., Preliminary report on the Ketchikan district, Alaska: Prof. Paper U. S. Geol. Survey No. 1, 1902. Wright, F. E. and C. W., The Ketchikan and Wrangell mining districts: Bull. U. S. Geol. Survey No. 347, 1908.

[2] Grant, U. S., and Higgins, D. F., Reconnaissance of the geology and mineral resources of Prince William Sound, Alaska: Bull. U. S. Geol. Survey No. 443, 1910.

[3] Grant, U. S., and Higgins, D. F., Preliminary report on the mineral resources of the southern part of Kenai Peninsula: Bull. U. S. Geol. Survey No. 442, 1910, pp. 166–178.

[4] Smith, P. S., and Eakin, H. M., A geologic reconnaissance in southeastern Seward Peninsula and the Norton Bay-Nulato region: Bull. U. S. Geol. Survey No. 449, 1911.

In the Yukon-Tanana region as a whole, but more especially in the Fairbanks district, there appears to be a close genetic relation between the gold deposits and the granite intrusive rocks. (See Pl. IV, p. 52.) At Fairbanks, where some work has been done on lodes, two systems of quartz veining have been recognized, both of which cut the Birch Creek schist. In addition to these, quartz stringers occur in the laminations of the schists and have been involved in the folding. The crosscutting quartz veins of the older generation appear to be larger than those of the later system, but while they carry some iron pyrite, the gold values appear to be low. After their introduction these veins were brecciated [1] and the bedrock was again fractured. The openings thus formed were impregnated by mineral-bearing solutions. In this way the older system of veins was enriched and some new veins were formed. The metal contents of the deposits due to the second period of mineralization are free gold, pyrite, stibnite, arsenopyrite, galena, and sphalerite. Quartz is the chief gangue mineral, with some calcite and locally orthoclase, calcite, albite, and tourmaline. The general distribution of the quartz veins indicates that there is a mineralized zone which parallels the main structures of the country rock but which is not very well defined (fig. 3). There have been some recent lode developments in the Chandalar placer district, north of the Yukon, where the conditions are probably similar to those at Fairbanks and where the deposits occur in close relation to intrusive rocks.

In addition to the fissure veins the Fairbanks district contains lode deposits which are probably comparable to those of the Juneau district described as mineralized zones. These are zones of fracture in the schists which have been permeated by mineral-bearing solutions. They are characterized by networks of small metalliferous quartz veins, forming stringer-lead deposits. In some places the quartz veining is only a very subordinate phenomenon, the main mass of the deposit being made up of pyritized schist carrying some gold. Only a few assays have been made on this type of deposit, but these indicate that the gold values are low. A deposit of this kind in the Bonnifield district is described by Mr. Capps on page 230. Here the country rock appears to be an altered and highly schistose rhyolite and not a sediment, as is the case in the Fairbanks district. It also seems probable that the gold of the placers of Willow Creek, in the Susitna basin (see pp. 145–146), has been derived from similar mineralized zones in a crystalline schist. This occurrence appears to be of a somewhat different type from those previously described, for it seems to lie within the zone of igneous metamorphism.

[1] Prindle, L. M., Auriferous quartz veins of the Fairbanks district: Bull. U. S. Geol. Survey No. 379, 1910, pp. 210-229.

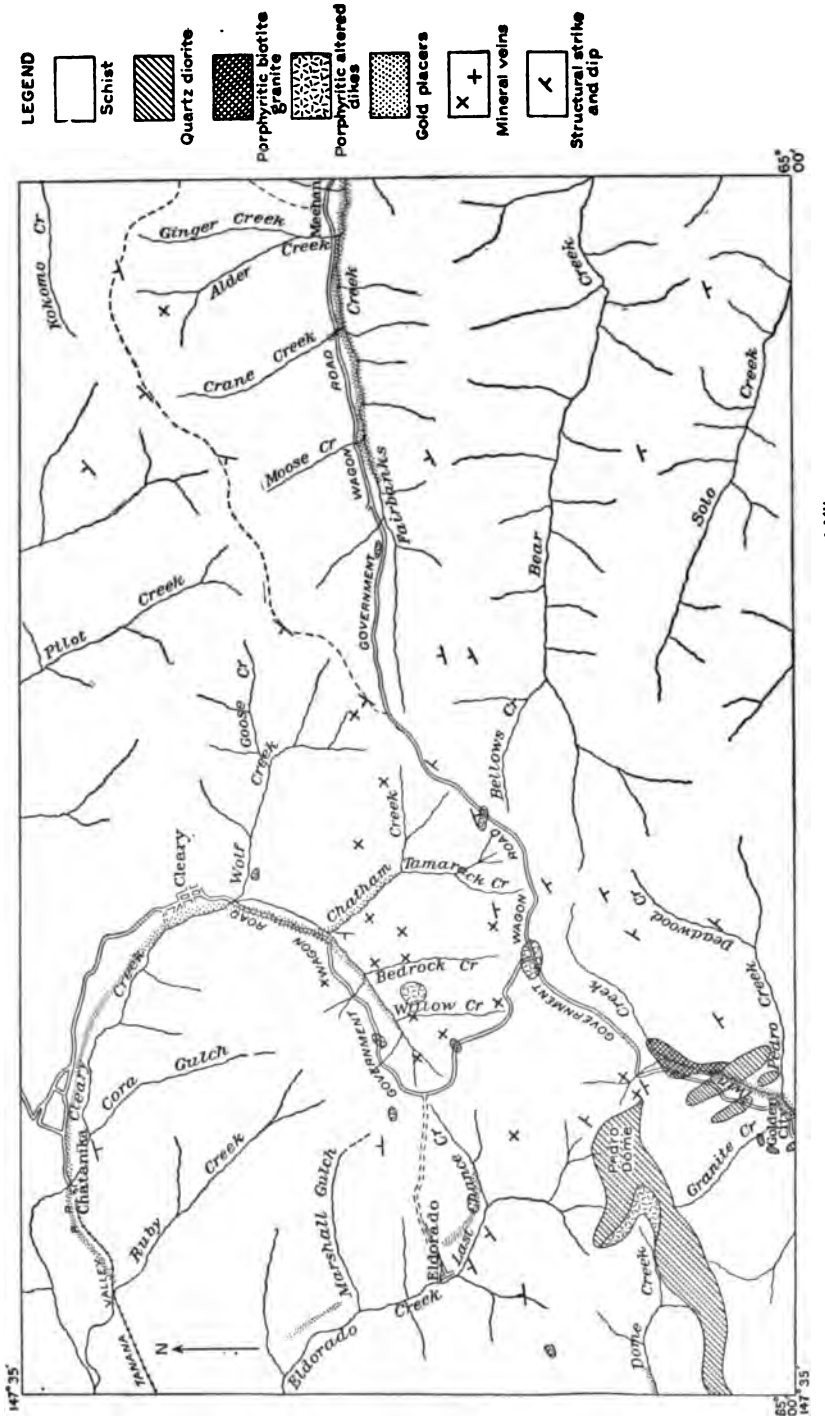

FIGURE 3.—Geologic sketch map of auriferous lodes in Fairbanks district. By L. M. Prindle, 1909.

As a general rule, the mineralized zones in the bedrock appear to occur in the schists, where the movements have not brought about notable open spacings but have formed crushed zones subsequently permeated by the mineral-bearing solutions. Such disseminated deposits seem to be more favorable to the formation of placers than where the ores occur in better-defined fissures. Where the physical character of the country rock has induced fractures with open spaces rather than shear zones, deposits of the fissure-vein type are more likely to be formed.

Auriferous veins that occur in crystalline limestones, usually near the contact with intrusive rocks, form another class of ore bodies which, however, differ from some of the silver-lead deposits to be described below only in the fact that they are valuable chiefly for their gold contents. This type of deposit is represented in southeastern Alaska by a number of ore bodies which have been more or less developed on Prince of Wales Island.[1] They occur typically in brecciated zones in crystalline and semicrystalline limestones, the openings thus formed having been penetrated by the mineral-bearing solutions and quartz and calcite, together with free gold, pyrite, chalcopyrite, tetrahedrite, galena, sphalerite, and arsenopyrite. These minerals have to a certain extent replaced the limestone, a fact which gives the ore bodies indefinite boundaries. Usually the values are distributed in shoots within the brecciated zone. Moffit and Knopf [2] have described the Royal Development Co.'s property at Jacksina Creek, in the Nabesna basin, as a mineralized contact zone between crystalline limestone and diorite. The entire mass has been sheared and heavily pyritized. At the surface at least it carries free gold, but it is not known what the form of the gold is below the zone of weathering.

Nearly all the gold deposits which have been described occur in rocks of sedimentary origin which have been subject to the influence of granitic intrusive rocks. In southwestern Alaska there is evidence of auriferous mineralization of volcanic rocks at and near the contact of granitic intrusives. Spurr [3] has described an example of this form of mineralization in a natural exposure on Skwentna River, north of Cook Inlet. The geologic relations are represented diagrammatically in figure 4. The mineralized area in the basalt along the granitic contacts in this and other localities contains pyrite, chalcopyrite, and galena, and assays show the presence of gold.

[1] Wright, F. E. and C. W., The Ketchikan and Wrangell mining districts, Alaska: Bull. U. S. Geol. Survey No. 347, 1908, pp. 81–82, 166–177. Brooks, A. H., Preliminary report on the Ketchikan mining district, Alaska: Prof. Paper U. S. Geol. Survey No. 1, 1902, pp. 51, 77–88.

[2] Moffit, F. H., and Knopf, Adolph, Mineral resources of the Nabesna-White River district, Alaska, Bull. U. S. Geol. Survey No. 417, 1910, p. 58.

[3] Spurr, J. E., A reconnaissance in southwestern Alaska: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 7, 1900, pp. 111–112, 259.

Evidence of mineralization in volcanic rocks of the same age has been found in other parts of this region.[1]

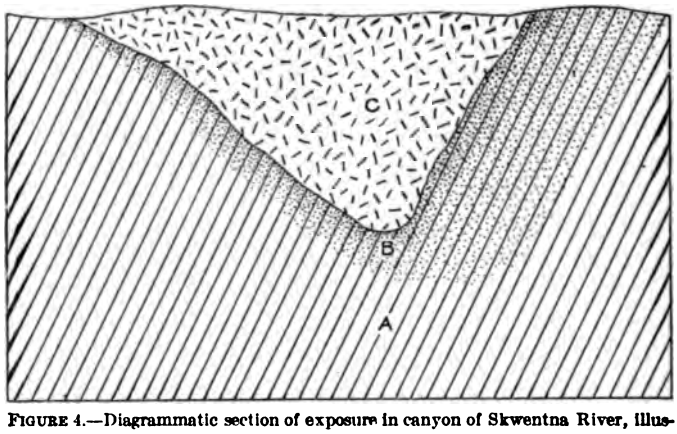

FIGURE 4.—Diagrammatic section of exposure in canyon of Skwentna River, illustrating mineralization in basalt along contact of granite dike. By J. E. Spurr, 1898. A, Ancient basalts; B, same, impregnated by metallic sulphides; C, intrusive granite.

The only developed lode in southwestern Alaska is the Apollo mine, on Unga Island. This deposit has been described by Becker [2] and others as occupying a zone of fracture in a country rock of dacite and andesite. Becker considered the volcanic rocks as of Miocene or post-Miocene age, but Atwood has called this determination in question and believes that they are certainly pre-Miocene and may be Mesozoic. Atwood also reports some dacite dikes on Unga Island, though none were observed in the immediate vicinity of the ore body. The metallic minerals of the deposit are free gold, pyrite, chalcopyrite, galena, zinc blende, and native copper. Other deposits of similar character have been noted in the neighborhood. There is no direct evidence of the influence of intrusives on this mineralization.

Some auriferous mineralization [3] has also been noted on Unalaska Island, at the east end of the Aleutian chain. Here the bedrock consists of andesitic volcanic rocks, whose age is unknown but is probably Mesozoic. A large granitic stock lies near this occurrence, and there is evidence that it has had some mineralizing influence.[4]

LODE DEPOSITS IN THE INTRUSIVE ROCKS.

The lode deposits in the intrusive rocks include those in shear zones in massive granite or diorite and also mineralized dikes. A

[1] Brooks, A. H., The Mount McKinley region, Alaska: Prof. Paper U. S. Geol. Survey No. 70, 1911, pp. 163–164.

[2] Becker, G. F., A reconnaissance of the gold fields of southern Alaska: Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1898, pp. 12, 83–85. Martin, G. C., Gold deposits of the Shumagin Islands: Bull. U. S. Geol. Survey No. 259, 1905, pp. 100–101. Atwood, W. W., Mineral resources of southwestern Alaska: Bull. U. S. Geol. Survey No. 379, 1909, pp. 149–151.

[3] Collier, A. J., Auriferous quartz veins on Unalaska Island: Bull. U. S. Geol. Survey No. 259, 1905, pp. 102–103.

[4] Jaggar, T. A., Journal of the Technology expedition to the Aleutian Islands in 1907: Reprinted from Tech. Review, vol. 10, No. 1, pp. 17–19.

good example of the first type is found in the Kensington lode, in the Berners Bay region of southeastern Alaska. According to Knopf [1] the ore body consists of an irregular mass of crushed diorite, marking a zone of movement within massive diorite walls (fig. 5). This fracture zone has been gashed by a multitude of quartz stringers, forming a stockwork deposit. It carries pyrite and, in at least one place, a little galena. More or less alteration of the diorite walls of the lode was noted. The outcrop of the Kensington lode is about half a mile east of a slate-graywacke series of Jurassic or Cretaceous age into which the diorite is intrusive. According to Knopf there are also well-defined fissure veins within the diorite of the Berners Bay region.

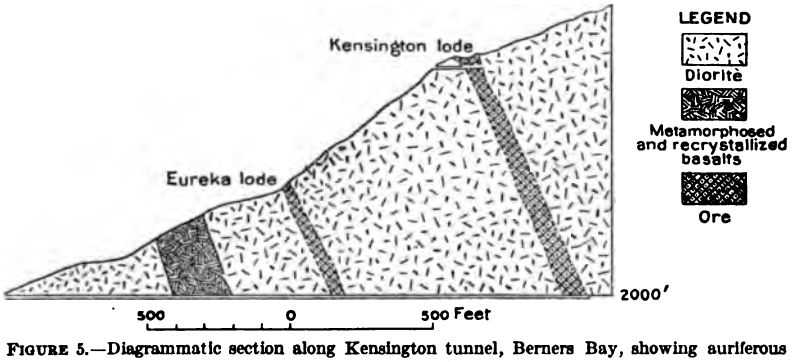

FIGURE 5.—Diagrammatic section along Kensington tunnel, Berners Bay, showing auriferous lode in diorite. By Adolph Knopf, 1909.

The ore deposits of the Treadwell group of mines also belong to this type of deposit, but the relations are not as simple as those at the Kensington. These mines, which are located on Douglas Island, near Juneau, and have produced over $40,000,000 worth of gold, form the largest mining enterprise in Alaska and one of the largest in the world, and their ore deposits will therefore be described in some detail. The following account is abstracted from Spencer's report: [2]

The ore bodies consist essentially of fractured and mineralized diorite dikes, which have penetrated a black slate parallel with and close to a greenstone contact (fig. 6). The greenstones appear to be altered volcanic rocks, and they, with the slates, constitute a part of the series which forms the country rock of much of the Juneau gold belt and is now regarded as probably of Jurassic or Cretaceous age. The fracturing of the diorite dikes has given opportunity for the mineralizing solutions to penetrate, and these have formed an intricate and irregular network of veinlets which can be designated as stringer leads. In addition to this, the ore-bearing solutions have permeated

[1] Knopf, Adolph, Geology of the Berners Bay region, Alaska: Bull. U. S. Geol. Survey No. 446, 1911, pp. 40–42.

[2] Spencer, A. C., The Juneau gold belt: Bull. U. S. Geol. Survey No. 287, 1906, pp. 88–116.

the diorite dikes, which have been largely altered to a mass of secondary minerals and vein matter. This mineralization has been traced by mine workings for almost 3,500 feet, with an extreme width of 400 feet. A depth of 1,600 feet has been attained without any notable change in values.

The dominating metallic minerals are free gold and pyrite, with considerable pyrrhotite and magnetite. In addition to these, chalcopyrite, galena, sphalerite, native arsenic, realgar, and orpiment have been found. Much of the gold is free, as high as 75 per cent of the assay value having been recovered. The important gangue minerals are feldspar, calcite, and quartz, with some rutile. Some of the original minerals of the diorite, such as feldspar, hornblende, and mica, are still present. Epidote, an alteration product of the primary minerals, is also found.

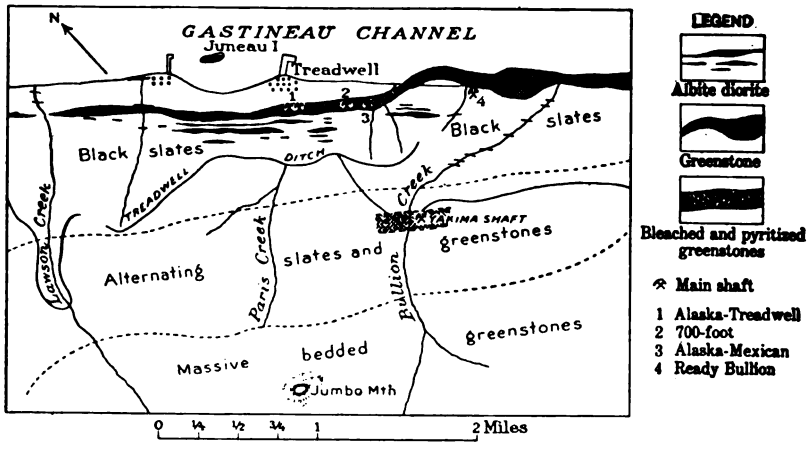

FIGURE 6.—Geologic sketch map of northwest end of Douglas Island. By A. C. Spencer, 1903.

The Treadwell ore bodies in their mode of origin and form of occurrence do not differ from some of the other deposits of the Juneau gold belt. Spencer has described the diorite adjacent to some of the lode deposits on Gold Creek as altered and more or less mineralized. It appears that in the Treadwell deposits the entire diorite mass was crushed, and the fractures thus formed gave opportunity for the mineral-bearing solutions to circulate, and the process continued until the whole dike was impregnated, while in deposits of the Kensington type the mineralization followed zones of crushing included within walls of massive igneous rocks.

Some auriferous veins have been found in a massive country rock of granite near Karta Lake, on Prince of Wales Island, in the Ketchikan district.[1] These veins follow fissures with well-defined walls and have a marked regularity in direction and thickness. In some places

[1] Wright, F. E. and C. W., The Ketchikan and Wrangell mining districts, Alaska: Bull. U. S. Geol. Survey No. 347, 1908, pp. 164-166.

diabase dikes have penetrated the fissures and have subsequently been fractured, and the auriferous quartz filling has been deposited along the spaces thus formed. The metallic vein minerals are free gold, pyrite, galena, and chalcopyrite, with a gangue of quartz, calcite, and possibly sericite.

The auriferous lodes of the Willow Creek region, north of Cook Inlet, described by Mr. Katz on pages 144–146, also belong to this type of deposit. These occur as fillings in what appear to be well-defined fissures in a quartz diorite country rock. Martin and Katz [1] have described a mineralized zone occurring within a granitic country rock near Cottonwood Bay, on Cook Inlet. This is described as a zone of shattering in a granite mass along which pyritiferous quartz veins have been deposited. Low gold values are reported. A mass of greenstone occurs near the ore body, and the granite is locally intruded by porphyry dikes.

At Orange Hill, in the Nabesna River basin, tributary to the Tanana, some auriferous mineralization has been found in a quartz diorite mass.[2] At this locality the diorite is cut by many small quartz stringers, some of them carrying pyrite and a few molybdenite. A similar deposit has been noted on Monte Cristo Creek, in the same region, and to the east on Beaver Creek, a tributary of upper White River. Several auriferous lodes have been found in the basin of Eureka Creek, also tributary to the White, which appear to be mineralized zones of fractures in a silicified feldspar porphyry.

The presence of auriferous deposits in granites and granodiorites is inferred from the distribution of placer gold in several districts. Thus the gold of the placers of Hill Creek, in the Fairbanks district, appears to have been derived from a mineralized zone in the margin of a granite stock. Mr. Maddren's description of the placers of the Iditarod (pp. 245–270) suggests that the gold was in part derived from a granite bedrock source. The writer [3] has also noted the occurrence of a mineralized zone in a granite 15 miles below Robertson River, on the north side of the Tanana Valley. Here both gold and pyrite were found disseminated in a brecciated zone about 10 feet wide, traversing a granite mass.

Mineralized dikes are not uncommon in many districts and some of these carry gold values. Such deposits have been found at the Sea Level mine and near Hollis, in the Ketchikan district.[4] Here the country rock is chiefly greenstone and calcareous schist (Mesozoic

[1] Martin, G. C., and Katz, F. J., Outline of geology and mineral resources of the Iliamna and Clark lakes region: Bull. U. S. Geol. Survey No. 442, 1910, p. 194.

[2] Moffit, F. H., and Knopf, Adolph, Mineral resources of the Nabesna-White River district: Bull. U. S. Geol. Survey No. 417, 1910, pp. 58–60.

[3] Brooks, A. H., Reconnaissance in the Tanana and White River basins, Alaska, in 1898: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 7, 1900, p. 487.

[4] Brooks, A. H., Preliminary report on the Ketchikan mining district, Alaska: Prof. Paper U. S. Geol. Survey No. 1, 1902, pp. 66–67, 91–93. Wright, F. E. and C. W., The Ketchikan and Wrangell mining districts, Alaska: Bull. U. S. Geol. Survey No. 347, 1908, pp. 144–146, 160–161.

or late Paleozoic), which have been crosscut by porphyry dikes. These dikes have, in turn, been fractured and invaded by mineral-bearing solutions that deposited pyrite, galena, sphalerite, with some native gold, and quartz and a little muscovite as gangue minerals. The dike rock itself has in places been heavily mineralized.

At the Crackerjack mine, near Hollis, the country rock is slate, more or less graphitic, which has been invaded by a porphyry dike. The ore body lies adjacent to this dike, but the dike itself has been epidotized and pyritized. The ore carries pyrite, galena, sphalerite, and an undetermined black antimony or bismuth mineral, with quartz and a little calcite as gangue minerals. In both localities there are deposits of similar types which are not so intimately associated with the dikes.

A pyritized dike rock, which is associated with an auriferous lode deposit in the Moose Pass district of Kenai Peninsula, has been described by Grant and Higgins.[1] The dike is made up of a fine-grained aggregate of plagioclase, quartz, mica, and probably orthoclase, with scattered crystals of arsenopyrite. The mica is of a light-green color and is secondary after the feldspar. Maddren[2] has noted pyritized dikes which carry gold in association with quartz veins in the Innoko district. In this field intrusive granites are known to be close at hand.

LODES OF SEWARD PENINSULA.

The gold-bearing lodes of Seward Peninsula are here described separately because it can not be proved that they bear a genetic relation to intrusive rocks as do most of those already described. Smith,[3] to be sure, considers, that the intrusive granitic rocks of the Kigluaik Mountains were injected at the same time as some of the quartz veins of the Solomon-Casadepaga region. He also cites the presence of tourmaline in many of the rocks as evidence that granitic intrusives may underlie areas where they do not outcrop. The facts remain, however, that in those parts of the peninsula which, from the evidence of placer gold, must have been heavily mineralized no granitic intrusive rocks have been found and that no auriferous deposits have been found in the regions which are known to have been intruded by granite. Moreover, the type of mineralization in areas that have been invaded by granite has not produced ore bodies valuable for gold but deposits carrying tin, tungsten, galena, etc., and these (see pp. 87–90) appear to differ essentially from the veins and mineralized zones which have yielded the placer gold. It is therefore at least an open question whether this auriferous mineralization bears any direct genetic relation to the granitic intrusives.

[1] Grant, U. S., and Higgins, D. F., Preliminary report on the mineral resources of the southern part of Kenai Peninsula: Bull. U. S. Geol. Survey No. 442, 1910, pp. 171-172.

[2] Maddren, A. G., The Innoko gold placer district: Bull. U. S. Geol. Survey No. 410, 1910, p. 64.

[3] Smith, P. S., Geology and mineral resources of the Solomon and Casadepaga quadrangles: Bull. U. S. Geol. Survey No. 433, 1910, pp. 132–133.

The writer [1] has shown elsewhere that the auriferous lode deposits of Seward Peninsula can be classed in two general groups—fissure veins and impregnated zones of fracture. There is also an older series of quartz veins, which lies parallel to the foliation of the schists and has been deformed with them, and these, too, locally carry sulphides and gold.

The distribution of the gold placers in the peninsula has helped to indicate the locus of auriferous mineralization in the bedrock where no other direct evidence was available. This class of evidence goes to show that, in the peninsula as a whole, the limestone-schist contacts were the most favorable places for auriferous mineralization.[2] An example of the relation of the mineralization to the limestone-schist contact is shown in the accompanying sketch map of the Ophir Creek region (fig. 7). The distribution of the placer gold at this locality indicates that it had its source in the limestone-schist contact. Moreover, at several places where this contact was studied in the field evidence of shattering and mineralization was observed. (See section A–B, fig. 7.)

Smith [3] has described the mineral veins of the Solomon-Casadepaga region in considerable detail, and those of the rest of Seward Peninsula are probably similar to these. He shows that there is an older system of quartz veining which may have been formed at a number of different periods of intrusion, all previous to the last epoch of intense deformation. The rock movement deformed the veins, which are now represented by blebs and bunches of quartz, irregularly distributed along the planes of foliation.

Besides being intensely folded and broken, the veins were crushed and then more or less recrystallized. The older veins are most abundant in the schists but occur also in the limestone, where they have usually not been much deformed. Metallic minerals are not common in these deposits, but some of them carry a little gold, some a little sulphide, and some rutile. Most of the younger series of quartz veins, as described by Smith, follow fissures which intersect the lamination of the country rock at different angles. These veins have as a rule suffered little deformation but are locally faulted. Some of them show comb structure and most of them have well-defined walls. These veins are again divisible into two types, one carrying locally visible free gold, with a gangue of quartz and but little sulphide, and the other carrying copper, iron, arsenic, and antimony sulphides, with no visible free gold.

Smith states that quartz veins occur in all the formations mapped, but they seem to be most abundant in the schists and slate. It

[1] Collier, A. J., Hess, F. L., Smith, P. S., and Brooks, A. H., The gold placers of parts of Seward Peninsula: Bull. U. S. Geol. Survey No. 328, 1908, pp. 110–139.

[2] Idem, pp. 121–124. Smith, P. S., Geology and mineral resources of the Solomon and Casadepaga quadrangles: Bull. U. S. Geol. Survey No. 433, 1910, pp. 141–142.

[3] Smith, P. S., Bull. U. S. Geol. Survey No. 433, 1910, pp. 89–93.

appears, from his work as well as that of others, that the limestone-schist contacts afforded conditions favorable to mineralization. The lithology of the country rock, however, except in so far as it affected

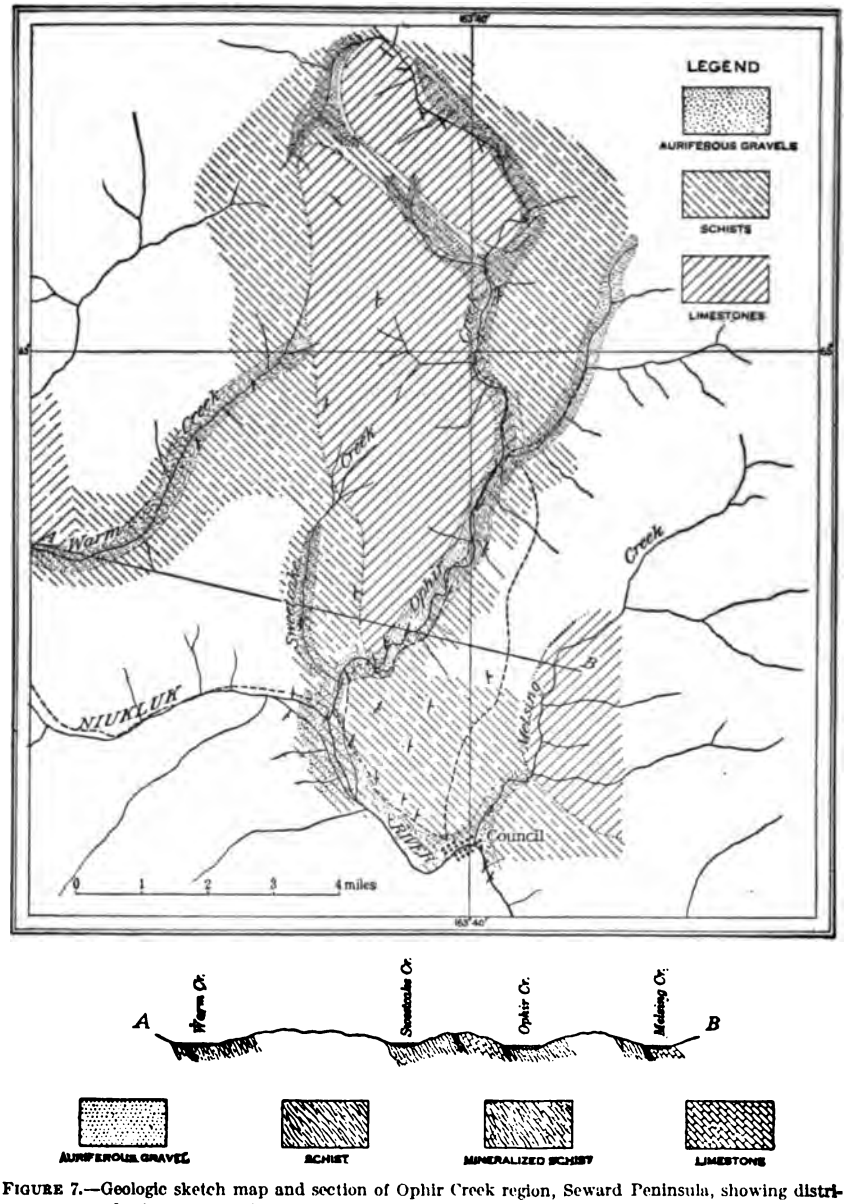

FIGURE 7.—Geologic sketch map and section of Ophir Creek region, Seward Peninsula, showing distribution of gold and of mineralization in relation to the limestone-schist contact.

the character of the fissuring, does not seem to have any influence on the formation of quartz veins. In the Solomon region the veins occurring in the Hurrah slate appear to be most persistent. This

rock is well jointed and in places the deposits occur as a stockwork of veins, thus forming a transition to the impregnated zone and fracture type of deposit.

The Big Hurrah mine, in the Solomon basin, is the only auriferous-quartz deposit which has been developed to a productive basis. The country rock is a hard black graphitic quartzite [1] (Hurrah slate), which is much fractured and breaks into rectangular blocks. Numerous fractures occur throughout this formation and in many places it is seamed with quartz veins and stringers. These quartz veins, although they are believed to belong to the youngest system of veining, are more or less deformed. The gold of the Big Hurrah lode is almost entirely free and little or no sulphide is present. Much of the ore is banded with flakes and layers of graphite and graphitic schist. The vein has been opened to a depth of about 250 feet without any noteworthy changes in the character of the ore.

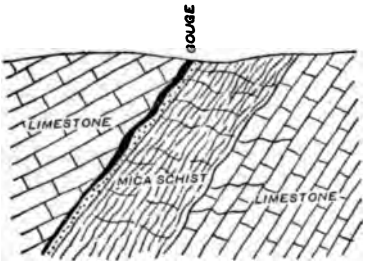

FIGURE 8.—Diagrammatic section of mineralized schist near Bluff, Seward Peninsula. By Alfred H. Brooks, 1905.

Smith also describes some calcite veins occurring in or close to limestone bedrock in the Solomon region. These veins, he states, carry no metallic minerals. It should be noted, however, that near Nome free gold has been found in calcite veins.

The more disseminated types of auriferous deposits of the peninsula, here called mineralized zones of fracture, are probably more common than fissure veins. In general they represent zones of fractured bedrock which have been permeated with mineral-bearing solutions. Some of these contain veins which may be stockwork or stringer-lead deposits. In others there is but little quartz and the deposit is defined by a zone of the bedrock which is heavily pyritized and in some places auriferous. Very few of these deposits are sufficiently well exposed to permit exhaustive study. It is not definitely known whether these deposits represent the older or the younger system of veining, but they probably belong to the younger. Mineralization of this type seems to be most pronounced at the limestone-schist contacts, where its distribution was determined by the fractures resulting from movements along the contact planes between the two formations.

Smith [2] has described the mineralized zones in the schist-limestone contacts of the Solomon and Casadepaga region as consisting of replacements of limestone by quartz with more or less sulphide minerals, of which chalcopyrite is most common. The writer's own

[1] Smith, P. S., Geology and mineral resources of the Solomon and Casadepaga quadrangles: Bull. U. S. Geol. Survey No. 433, 1910, pp. 144-145. Collier, A. J., and others, Gold placers of parts of Seward Peninsula: Bull. U. S. Geol. Survey No. 328, 1908, pp. 228-231.

[2] Smith, P. S., op. cit., pp. 141-142.

observations go to show that at some localities the zone of mineralization may be confined entirely to the schist but close to the limestone contact. An example of this is shown in figure 8, which is a diagrammatic section of a natural exposure near Bluff. Here a mass of schist, which is probably an altered igneous rock, is included between limestone walls. A series of gash veins cut across the foliation of the schist. These veins also penetrate the footwall of limestone. The metalliferous minerals noted in this deposit are pyrite, arsenopyrite, and chalcopyrite and are said to carry some gold.

COPPER.

OUTLINE OF CLASSIFICATION.

Practically all the Alaskan copper deposits thus far developed fall into five general groups determined by mode of origin or mode of occurrence. These are (1) deposits in zones of igneous metamorphism and chiefly near the contact of limestones with granodiorites and diorite intrusive rocks; (2) deposits associated with intrusive rocks, but not within the zone of igneous metamorphism; (3) deposits disseminated in intrusives; (4) deposits associated with ancient volcanic rocks and sediments; and (5) copper-bearing amygdaloids. Each of these groups admits of further subdivisions, which will be discussed later. This classification is summarized below.

Classification of Alaska copper deposits.

1. Deposits in zones of igneous metamorphism.
   - (*a*) Contact-metamorphic deposits of limestones and intrusive rocks.
   - (*b*) Contact-metamorphic deposits of clastic and intrusive rocks.
2. Deposits associated with intrusive rocks, but not in zones of igneous metamorphism.
3. Deposits disseminated in intrusive rocks.
4. Deposits associated with ancient volcanic rocks and sediments.
   - (*a*) Deposits occurring in greenstones and argillites.
   - (*b*) Deposits occurring in greenstones and limestones.
5. Copper-bearing amygdaloids.

DEPOSITS IN ZONES OF IGNEOUS METAMORPHISM.

Copper-bearing lodes occurring in the contact zones of limestones and intrusive rocks are among the most widely distributed types of deposit in Alaska. The intrusive rocks are probably of Mesozoic age. Such ore bodies are especially abundant on parts of Prince of Wales Island, in the Ketchikan district of southeastern Alaska.[1] The geologic features of some of the best known of these deposits are shown on the accompanying map of the Copper Mountain region (Pl. V). Here an irregular stock of granite is surrounded by limestones and

[1] Wright, C. W., Mining in southeastern Alaska: Bull. U. S. Geol. Survey No. 379, 1910, pp. 80–82.

Perry
55°
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Deer Bay
N

metamorphic schists and the copper deposits occur in the contact zone of limestone or schist adjacent to the granite. The ore bodies occur only where igneous metamorphism has taken place in the sediment adjacent to the granite, and this is by no means the case along the entire contact. Where this alteration has occurred a greenish or reddish rock has been formed composed chiefly of garnet and epidote and almost always carrying some disseminated chalcopyrite, pyrrhotite, and magnetite. This contact zone varies from 25 to 250 feet in width.

The ore bodies, which are of irregular outline and distribution, consist of chalcopyrite and pyrite in a gangue of garnet, epidote, calcite, and some quartz. They carry both gold and silver. Some of the deposits contain much magnetite; others lack this mineral but carry pyrrhotite. According to Wright the lodes were formed from solutions which penetrated along the contact, along preexisting fissures, or along solution channels in the limestone, or are replacement deposits of limestone where no notable opening previously existed. The important ore bodies usually lie along the contact, but from these smaller bodies of vein material branch out, penetrating both walls locally to a distance of a thousand feet.[1] The deposits in the schist near the contact are usually less concentrated than those in the limestone and are usually disseminated[2] along the planes of foliation. As a rule they do not form commercial ore bodies.

Many of the copper deposits of the east side of Prince of Wales Island, including those of Kasaan Peninsula, in the Karta Bay region, are also of the contact type. Wright's investigations[3] show that the sediments of this field include a series of conglomerates and graywackes and tuffaceous schists, which occur in broad areas, and narrow belts of limestones. The whole series has been folded and then extensively intruded by granular rocks which include granites, granodiorites, diorites, and syenites. These intrusives, which occur as irregular stocks and dikes, were followed by an injection of pegmatite dikes and, still later, by a widespread intrusion of porphyry dikes.

Contact deposits similar to those of Copper Mountain form the most widely distributed ore bodies of this region. They occur chiefly in the zone of igneous metamorphism at the contact of limestone and intrusive rocks. A few have been found at the contact of the graywacke-tuff series and the intrusives. The ores of the limestone contact are chalcopyrite, pyrite, pyrrhotite, and magnetite, with a gangue of epidote, garnet, amphibole, calcite, and orthoclase. These

[1] Wright, F. E. and C. W., The Ketchikan and Wrangell mining districts, Alaska: Bull. U. S. Geol. Survey No. 347, 1908, pp. 95-96.

[2] Brooks, A. H., and others, Mineral resources of Alaska—Report on progress of investigations in 1908: Bull. U. S. Geol. Survey No. 379, 1909, p. 81.

[3] Wright, C. W., Mining in southeastern Alaska: Bull. U. S. Geol. Survey No. 379, 1909, pp. 76-79.

deposits are typically irregular masses varying from 10 to 250 feet in width.

The shape of one of these ore bodies and its relation to the intrusive rocks is shown by the accompanying plan and section (fig. 9) of the workings of the Mount Andrew mine, on the southwest side of the Kasaan Peninsula. The ore bodies occur at the contact of a large intrusive mass and a belt of crystalline limestone.[1] In the plan and

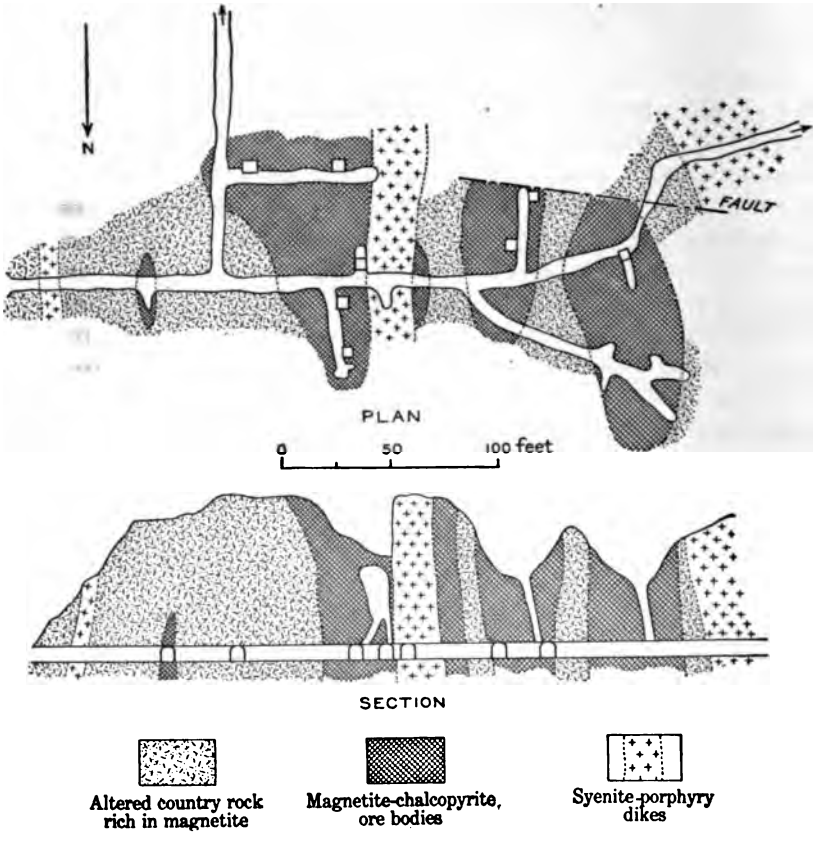


FIGURE 9.—Plan and cross section of Mount Andrew mine workings, Ketchikan district, showing position of ore bodies. By C. W. Wright, 1905.

section the altered country rock represents a metamorphic phase of the limestone and is made up of garnet, epidote, and calcite, together with a large amount of magnetite. This country rock has been cut by dikes of syenite, which are probably apophyses from the main mass of intrusive rocks that lies adjacent to the ore body on the east. The ore is composed essentially of chalcopyrite and magnetite and carries some gold and silver.

[1] Wright, F. E. and C. W., The Ketchikan and Wrangell mining districts: Bull. U. S. Geol. Survey No. 347, 1908, pp. 115–117.

In this same region there are copper-bearing lodes which occur in the form of lenses in shear zones in the graywacke and tuffaceous

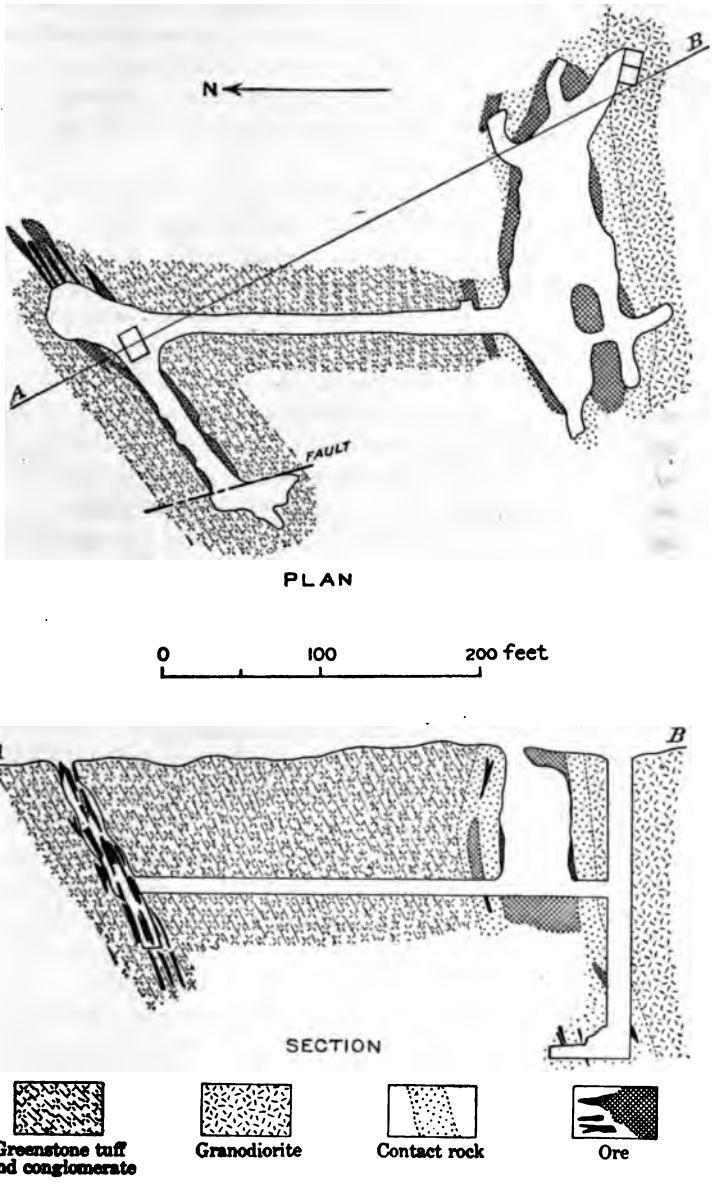


FIGURE 10.—Sketch plan and section of workings at Rush & Brown mine, near Karta Bay, showing ore bodies and relation of mineralization to contact between granodiorite and tuff and conglomerate. By C. W. Wright, 1905.

schist series but apparently in the zone of igneous metamorphism of intrusive masses. Their metallic minerals are chalcopyrite, pyrite, and usually sphalerite, with a quartz and calcite gangue. The Rush &

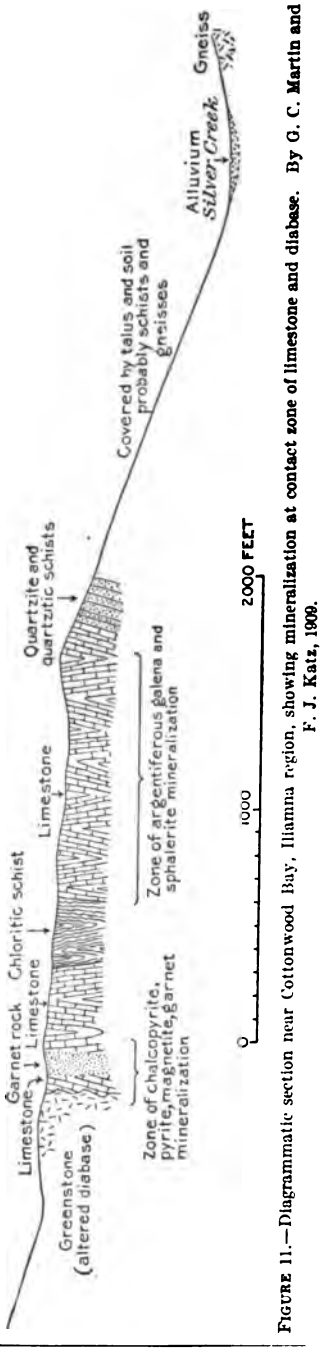


FIGURE 11.—Diagrammatic section near Cottonwood Bay, Iliamna region, showing mineralization at contact zone of limestone and diabase. By G. C. Martin and F. J. Katz, 1909.

Brown mine,[1] near Karta Bay, affords examples of both the contact-metamorphic ore bodies and those occurring in shear zones. Figure 10 indicates the geologic relations of the ore bodies at this locality. These deposits furnish the only example thus far developed in this district of igneous contact deposits in sediments other than limestones.

Moffit and Knopf[2] have described contact-metamorphic deposits of copper which occur in the basin of upper Nabesna River, tributary to the Tanana. These deposits are found in a crystalline limestone at or near the contact with dioritic intrusive rocks. The ores are bornite and chalcopyrite, associated with garnet, epidote, coarsely crystalline calcite, hematite, and scattered flakes of molybdenite. Some of these deposits also contain magnetite. The data at hand, which are fragmentary, as but little development work has been done, indicate that these deposits are similar in character to the contact deposits of southeastern Alaska.

The copper ores west of Cook Inlet, between Iliamna Bay and Iliamna Lake, occur in a contact zone[3] between limestone and a greenstone which is an altered diabase or diorite. The field relations are shown in figure 11. The mineralized zone, averaging 200 feet in width but in places reaching 300 feet, lies chiefly in the limestone but also in the greenstone. It contains chalcopyrite, pyrite, and magnetite, with a gangue of garnet, calcite, quartz, amphibole, and other minerals. The ore bodies consist of those parts of this mineralized zone which carry copper values with some gold.

[1] Wright, F. E. and C. W., The Ketchikan and Wrangell mining districts: Bull. U. S. Geol. Survey No. 347, 1908, pp. 123–125.

[2] Moffit, F. H., and Knopf, Adolph, Mineral resources of the Nabesna-White River district, Alaska: Bull. U. S. Geol. Survey No. 417, 1910, pp. 52–55.

[3] Martin, G. C., and Katz, F. J., The Iliamna and Clark lakes region: Bull. U. S. Geol. Survey No. 442, 1910, pp. 194–196.

These Iliamna deposits, so far as the meager information about them permits comparison, bear a close analogy to the better-developed lodes of Prince of Wales Island. While the intrusive is of a more basic character and more highly altered, the contact zone and the ores are very similar. It should be noted that the mineralized zone and the two wall rocks lie within a great stock of intrusive granite, probably of Mesozoic age.

DEPOSITS ASSOCIATED WITH INTRUSIVE ROCKS BUT NOT IN THE ZONE OF IGNEOUS METAMORPHISM.

Some of the copper deposits of the Ketchikan district in southeastern Alaska lie within the zone affected by intrusive rocks but not within the areas of igneous metamorphism.[1] These deposits occur in association with greenstone schists, chloritic schists, and sericite schists, and with argillites and other sedimentary rocks. The greenstone and chloritic schists are probably chiefly altered igneous rocks. Some of them are known to be sheared intrusives. In most localities where the deposits occur intrusive rocks are known to be near at hand, and these are believed to be of Mesozoic age.

These copper-bearing lodes, so far as determined, occur along zones of fracture and usually have lenticular form. In some localities the ores appear to have been deposited in open spaces; in others the ore bodies consist of masses of country rock which have been impregnated by the mineral-bearing solution. No evidence has been seen of replacement of the country rock such as has been noted by Grant and Higgins in the deposits on Prince William Sound. (See p. 81.) The mineralized zone may include one or more ore shoots in the form of bands, veins, or lenses, and these are usually separated from both walls by the impregnated rock carrying lesser values. These deposits are valuable chiefly for their chalcopyrite. They also carry pyrite, pyrrhotite, in some places magnetite, and a little hematite and galena, with a gangue of quartz and calcite, as well as the minerals of the country rock. Among the localities where such deposits are found are Skowl Arm and Niblack Anchorage, both on the east side of Prince of Wales Island. The deposits at the south end of Gravina Island are probably of the same general type.

Ore bodies also occur in the greenstone schists and quartzites which overlie the limestones of Copper Mountain (see Pl. V), a mile or two from intrusive granite. These include both fissure-vein and shear-zone deposits. The ores contain pyrite and chalcopyrite, with a small amount of sphalerite.

[1] Wright, F. E. and C. W., The Ketchikan and Wrangell mining districts, Alaska: Bull. U. S. Geol. Survey No. 347, 1908, pp. 128-140. Brooks, A. H., Preliminary report on the Ketchikan mining district: Prof. Paper U. S. Geol. Survey No. 1, 1902, pp. 74-96.

In this group should also be included copper-bearing fissure veins occurring in limestone of the Kasaan Peninsula region.[1] These veins carry chalcopyrite, galena, sphalerite, and tetrahedrite, with quartz, calcite, and barite as gangue minerals. In some places these deposits lie along the margins of intrusive dikes.

DEPOSITS DISSEMINATED IN INTRUSIVE ROCKS.

Copper ores occur as disseminated deposits in the intrusive rocks of the Kasaan Peninsula region.[1] The only commercial ore body of this type which has been developed is that of the Goodro mine, near the upper end of Kasaan Bay. This occurrence has been recently described by Knopf[2] as "a heavy green dioritic rock containing much biotite and, as the main copper-bearing mineral, scattered particles of bornite, with which are associated sporadic blebs of chalcocite and chalcopyrite." The ore body has been opened to a depth of 94 feet, where the copper content is said to be 2 per cent higher than at the surface. Knopf points out that this may be due to the greater prevalence of chalcocite on the lower level.

DEPOSITS ASSOCIATED WITH ANCIENT VOLCANIC ROCKS AND SEDIMENTS.

The fourth group of copper deposits comprises those which are associated with greenstones (altered volcanic rocks) and sediments of various types. These deposits, so far as known, have no direct relation to igneous intrusive rocks, but it is possible that in the deposits of the Prince William Sound type belonging to this group there may be a connection between the genesis of the ores and certain basic intrusive rocks. Of a different type, though belonging to this same general group, are deposits of the Chitina region which occur chiefly in limestones and are not connected with any intrusive rocks. While definite proof is lacking, it seems probable that the copper of both the Prince William Sound and the Chitina deposits was derived from copper minerals disseminated in the associated ancient volcanic rocks.

COPPER-BEARING LODES IN GREENSTONES AND ARGILLITES.

The best-known examples of the deposits in greenstones and argillites are those occurring in the Orca group of Prince William Sound and adjacent regions. The following description is abstracted from a report by Grant and Higgins.[3] The copper-bearing lodes occur along zones of fracture, in most of which shearing has taken

[1] Wright, C. W., Mining in southeastern Alaska: Bull. U. S. Geol. Survey No. 379, 1909, p. 78.
[2] Knopf, Adolph, Mining in southeastern Alaska: Bull. U. S. Geol. Survey No. 442, 1910, p. 141.
[3] Grant, U. S., and Higgins, D. F., Reconnaissance of the geology and mineral resources of Prince William Sound, Alaska: Bull. U. S. Geol. Survey No. 443, 1910, pp. 53–71.

place. These zones are mainly in greenstones that are altered basic lava flows and tuffs, with some intrusive rocks. Some of the mineralized shear zones occur in slates and graywackes and some along the contacts of the sediments and the greenstones. The shear zones strike parallel to the major structures of the region, with usually a steep dip. In some places the deformations have resulted in fracturing rather than shearing. So far as can be determined from the evidence in hand, the movements did not, as a rule, produce any notable open spaces, but there are exceptions to this, for at some localities fissure veins have been observed. Mineral deposition in the shear zones in part followed the open spaces thus formed and in part impregnated the country rock or replaced it where no notable open spacing occurred. Development has not proceeded far enough to admit of precise statement as to the shape of the ore bodies, but some of them at least appear to have a lenticular form, outlined by planes of movement. Some of the ore bodies have no well-defined walls. In many of the deposits there is an ore shoot, made up of more or less solid layers of metallic sulphide within the mineralized zone. These ore shoots vary more in dimensions from place to place than the deposits as a whole. Chalcopyrite is the most abundant of the metallic minerals and is usually associated with pyrrhotite. The proportion of these minerals varies greatly in a single ore body. Pyrite also occurs but is much less abundant. Among the rarer metallic minerals are galena, bornite, sphalerite, and magnetite. The chief gangue minerals are quartz, calcite, epidote, and chlorite. The ores that have been shipped from this district carried considerable silver but only a small amount of gold.

The best-developed ore bodies of the district are those of the Ellamar and Beatson-Bonanza[1] mines. At the Ellamar the lode consists of a lens-shaped ore body, whose greatest horizontal dimension is 190 by 80 feet, occurring in a slate-graywacke series. The mine workings extend to a depth of 600 feet. The ore body consists of chalcopyrite, pyrite, and pyrrhotite, with some included masses of country rock. At the Beatson-Bonanza the ore occurs in a zone of hard greenish flinty rock which, for want of a better name, can be designated a hornfels, though its sedimentary origin has not been proved. This hornfels, which forms the country rock at the mine, occurs in a belt of slates and graywackes. The ore, which is chiefly chalcopyrite, occurs in fractures and as replacements in the hornfels. It is found disseminated in the hornfels and also as bands of nearly pure sulphides (chalcopyrite, pyrite, and pyrrhotite), which are in general parallel to the bedding of the slates and graywackes. Some

[1] Formerly called the Bonanza, but not to be confused with the mine of that name in the Chitina region.

faulting has taken place since the ore was deposited. Some basic dikes are present.

Among the deposits differing from those described above may be mentioned one occurring on Knight Island and near Mummy Bay, in which a coarse-grained diabase has been heavily charged with pyrrhotite and chalcopyrite. Another type, which is found on Orca Bay, is made up of epidotized stringers which occur in a crushed amygdaloidal basalt. These stringers carry native copper, chalcopyrite, bornite, and chalcocite in a gangue of quartz and epidote. In a few localities there are some well-defined fissure veins filled with quartz, pyrrhotite, pyrite, and chalcopyrite.

While these deposits have not been traced to the mineralizing influence of igneous rocks, yet Grant and Higgins have pointed out that certain basic intrusives are later than the shear zones and that the ores may bear a genetic relation to these rocks. Copper-bearing lodes of similar geologic occurrence have been found in the eastern part of Kenai Peninsula.[1]

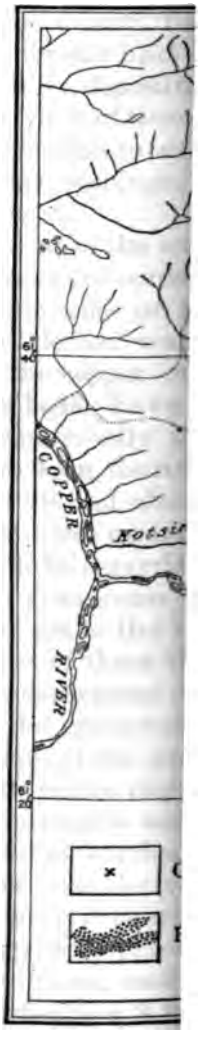
COPPER-BEARING LODES IN ASSOCIATION WITH GREENSTONES AND LIMESTONES.

The copper deposits which stretch along the southern flank of the Wrangell Mountains, in the Kotsina-Chitina district, have been investigated by a number of geologists,[2] but most of the following account is based on the observations and deductions of Moffit. With regard to copper resources, two formations of this field are of first importance. The older comprises a great sequence of ancient basaltic lavas, some of which are amygdaloidal, with which some sedimentary beds are intercalated. This series aggregates at least 3,000 to 4,000 feet in thickness and is called the Nikolai greenstone. This is conformably overlain by the Chitistone limestone, of Triassic age, made up of heavily bedded bluish-gray limestone aggregating 3,000 to 4,000 feet in thickness. The contact between these two formations forms the locus of the most important ore bodies which have yet been developed (see map, Pl. VI), but some copper occurs throughout the greenstone and copper lodes have been found in the limestone a long distance from the contact. The largest ore bodies so far found are those occurring within the limestone and within a thousand feet of the greenstone contact.

The conditions favorable to the deposition of copper appear to have been determined chiefly by the readiness with which the mineral-bearing solutions could circulate. Therefore the openings developed

[1] Grant, U. S., and Higgins, D. F., Preliminary report on the mineral resources of the southern part of Kenai Peninsula: Bull. U. S. Geol. Survey No. 442, 1910, pp. 166-178.

[2] Schrader, F. C., and Spencer, A. C., Geology and mineral resources of a portion of the Copper River district, Alaska, a special publication of the U. S. Geol. Survey, 1907. Moffit, F. H., and Maddren, A. G., Mineral resources of the Kotsina-Chitina region, Alaska: Bull. U. S. Geol. Survey No. 374, 1909. Moffit, F. H., and Capps, S. R., Geology and mineral resources of the Nizina district, Alaska: Bull. U. S. Geol. Survey No. 448, 1911.


COPPER
RIVER

by faulting, jointing, and shearing, which gave opportunity for this circulation, constituted one of the prime requisites to the formation of ore bodies. The most promising deposits have been found along lines of movement which intersected the contact at different angles. It also appears that the plane of the contact between the two formations locally furnished passages for the solutions, even where no movement had taken place.

A few deposits which can be classed as fissure veins have been found, but most of them are more or less irregularly distributed and represent replacements of the country rock by materials brought in solution along openings, many of which were very minute, caused by deformation.

Most of the sulphide copper deposits within the greenstone thus far prospected consist of irregular masses and blebs of the ore, distributed along zones of fracture, and in many places do not appear to have well-defined walls. Bornite and chalcopyrite are the most common of the copper ores in the greenstone, but some promising chalcocite ore bodies have been found. The copper deposits within the greenstones usually include very little gangue. Some vein deposits have also been found in the greenstone, and their ores are also chiefly bornite and chalcopyrite with a gangue consisting mainly of calcite, with some quartz and usually epidote.

Moffit regards the native copper deposits that have been found in the greenstone of the Kotsina-Chitina belt as probably secondary and due to the reduction of sulphides or oxides. The most common types of these deposits are those in which grains and irregular and tabular masses of native copper are distributed through certain zones in the greenstones. These are most common in the amygdaloidal phases of the greenstone, and here many of the amgydules are filled with native copper. At several localities carbonaceous matter and copper oxide occur with these native copper deposits. Some of the alluvium carries a large amount of placer copper which appears to have been derived from deposits of this type. Much of this placer copper is in thin sheets as if derived from planes of jointing or foliation. Nuggets of placer copper weighing several hundred pounds are not uncommon, and one mass of native copper found on Nugget Creek weighed 2 or 3 tons.

The most important feature of the deposits in the limestone are summarized by Moffit and Capps [1] as follows:

> Copper deposits in limestone were formed by replacement of the limestone as a whole by copper minerals in solutions circulating along fracture planes such as faults, shear zones, or joints. The copper minerals are chalcocite and bornite, accompanied by malachite, azurite, and in places covellite as alteration products. As a rule, the

[1] Moffit, F. H., and Capps, S. R., Geology and mineral resources of the Nizina district, Alaska: Bull. U. S. Geol. Survey No. 448, 1911, p. 79.

boundary between ore and country rock is distinct, although the form of the ore body itself may be very irregular. This is particularly true where the copper mineral is chalcocite. In deposits of bornite in limestone a dissemination of the copper mineral through the adjacent country rock was noticed, and in such examples there is a gradation from ore to country rock similar to that in the greenstone deposits. One of the best examples of this kind shows a large proportion of chalcocite associated with the bornite, and the deposition of the copper was accompanied by a thorough silicification of the limestone. Large masses of chalcocite like that of the Bonanza property are distinctly replacement deposits in fracture zones. No fragments of limestone are included in the body of the ore, although isolated masses of chalcocite are scattered through the limestone. The ores are most frequent near the limestone-greenstone contact, yet some of them must be fully 1,000 feet above the base of the limestone. It is a notable fact that azurite is far more common as a secondary oxidation product in

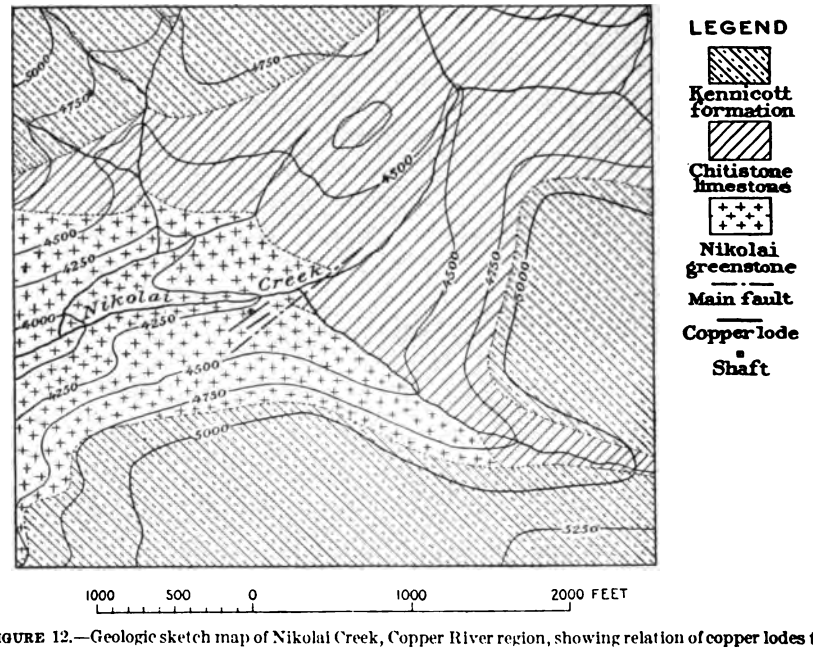


FIGURE 12.—Geologic sketch map of Nikolai Creek, Copper River region, showing relation of copper lodes to fault zone and to limestone-greenstone contact. By F. H. Moffit and S. R. Capps, 1909.

the limestone replacement deposits than malachite and that it is not common in the deposits in greenstone. Small veins of azurite with cores of chalcocite show distinctly that the azurite in the Bonanza mine was produced by the alteration of chalcocite. Covellite originated in a similar manner.

The Nikolai copper property, located on a tributary of McCarty Creek, affords an example of the vein type of deposit in the greenstone. It lies in a fault zone which intersects and offsets the limestone-greenstone contact. (See fig. 12.) The vein has been traced horizontally within about 400 feet of this faulted contact, though its nearest point to the limestone is only about 50 feet distant. According to Moffit the deposit is in part a replacement of the greenstone, in part a filling of a preexisting fissure. Chalcopyrite is the principal copper

mineral, but with it is considerable bornite. With these are associated calcite, epidote, and quartz as gangue minerals.

At the Bonanza mine is the largest and best-developed ore body of the district. The mine is located at an altitude of about 6,000 feet,

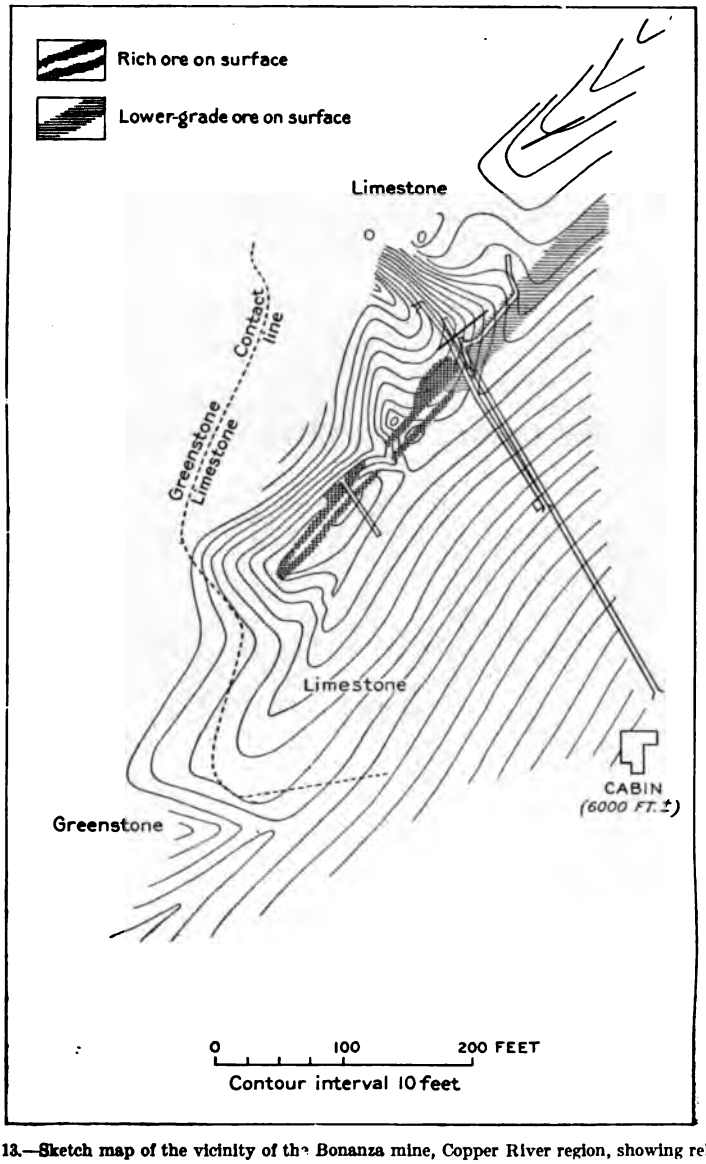


FIGURE 13.—Sketch map of the vicinity of the Bonanza mine, Copper River region, showing relation of copper deposits to limestone-greenstone contact. By F. H. Moffit and S. R. Capps, 1909.

near the crest of the ridge which separates the drainage of upper Kennicott River from McCarty Creek. The deposit includes bodies of chalcocite, which occur in a zone of fracture traversing the lime-

stone and trending northeastward, in which direction it has been traced for about 1½ miles. The limestone-greenstone contact, which is about 40 feet from the nearest point on the ore body, is not offset by the fault but has been subjected to some minor displacements. (See fig. 13.) The zone of fracture has been affected by more than one line of movement. In the sheeted zone formed by this faulting, which is from 50 to 60 feet wide, occur the copper deposits, which range from small, irregularly distributed masses of copper to large, well-defined veins. The deposit appears to end above the limestone-greenstone contact, but a little mineralization is observable in the greenstone.

The ore is chalcocite, and but little else is included in the deposit. Azurite has been formed as an oxidation product, and some covellite is also present.

It is a significant fact that promising deposits of similar character occur on the extension of this zone of fracture on the McCarty Creek side of the divide and have been prospected. There appears, however, to be a barren area along the fracture zone between the Bonanza and the deposits on McCarty Creek, but even here copper-bearing minerals are found in places.

No other copper deposits have been developed in Alaska which are similar in association to those of the Kotsina-Chitina region. There are, to be sure, copper lodes in limestone and in greenstone in different parts of the Territory, but in none of these are the conditions of occurrence exactly similar to these described above. Some of the copper deposits of the White and Nabesna River regions occur in limestone, but these are for the most part in the contact zones of intrusive rocks [1] and have already been described. There are also some deposits in the ancient volcanic rocks of this northern field which may prove to be similar to those in the greenstone of the Chitina Valley. On the whole, however, the deposits of the two copper belts on the north and south sides of the Wrangell Mountains appear to be dissimilar in occurrence and genesis.

COPPER-BEARING AMYGDALOIDS.

Primary native copper has been found by Moffit and Knopf [2] in the upper White River basin and constitutes the only occurrence of this kind known in Alaska. The property containing this deposit, called the Copper King claim, is located at the head of the Middle Fork of White River. The country rock is a series of basaltic flows, breccias, and tuffs of Carboniferous age. To quote from Moffit and Knopf's report:

> Native copper is apparently limited in its occurrence to a certain definite volcanic sheet—a reddish lava that is locally amygdaloidal to a high degree. For 200 feet

[1] Moffit, F. H., and Knopf, Adolph, Mineral resources of the Nabesna-White River district, Alaska: Bull. U. S. Geol. Survey No. 417, 1910, p. 54.

[2] Idem, pp. 55–56.

along the outcrop of this sheet metallic copper intergrown with prehnite, calcite, and zeolites can be found here and there in encouraging amounts. The cupriferous portion of the amygdaloid appears to be about 6 feet thick, but as almost no development work has been done on the property [1908], figures of this kind have little value. The copper occurs as irregular reticulating masses of metal several inches long and as small lumps and minute particles embedded in the minerals that fill or line the former vesicles in the lava flow. In places these minerals either ramify in small veinlets through the body of the rock surrounding the amygdules or form irregular masses, and such places are eminently favorable for metallic copper.

These deposits are considered primary in the sense that the copper was deposited in the amygdaloidal or native state and is not the result of oxidation of sulphides, as is believed to be the case in the copper-bearing amygdaloid of the Nikolai greenstone.

SILVER, LEAD, AND ZINC.

Practically all the gold deposits and many of the copper deposits carry more or less silver. Galena, as has been shown, is not uncommon as an accessory mineral in these deposits. There are also some lodes in Alaska which are regarded as valuable because of their silver and lead contents. These nearly always carry also some subordinate gold values. Argentiferous galena-bearing fissure veins[1] have been developed on the south arm of Cholmondeley Sound—an indentation on the east side of Prince of Wales Island, in the Ketchikan district. These veins cut across both schists and limestone. According to the Wrights, where they crosscut the limestones they are replacement deposits. These veins carry galena, with a small amount of chalcopyrite and sphalerite, in a gangue of quartz, siderite, and calcite. Another group of galena deposits occurs about 12 miles east of Wrangell, in southeastern Alaska.[2] Here there is a slate-schist belt about a mile wide lying between granite areas. These altered sediments are traversed by acidic porphyry and aplite dikes, and in these or along the contacts the galena deposits occur. The deposits are fissure veins, which appear to be persistent. They are heavily mineralized with galena, sphalerite, pyrite, and chalcopyrite.

Some galena deposits[3] have also been opened on Coronation Island, which lies near the entrance to Chatham Strait, in southeastern Alaska. The bedrock of the island, so far as known, consists of Paleozoic limestones and schists, which have been intruded by granite. The ore deposits are irregular masses within a limestone country rock. Besides the galena, tetrahedrite and sphalerite are present in the ores.

Among the many localities where galena ore deposits have been found in Alaska, that in the Fish River basin, in the eastern part

[1] Wright, F. E. and C. W., The Ketchikan and Wrangell mining districts, Alaska: Bull. U. S. Geol. Survey No. 347, 1908, pp. 187–188.
[2] Idem, pp. 188–190.
[3] Idem, pp. 190–191.

of Seward Peninsula, deserves mention. One of the first attempts at lode mining in Alaska was at this locality, at the Omilak mine, in 1882. According to Smith and Eakin,[1] the country rock consists of crystalline limestone and schists and also some more or less schistose igneous rocks which are classed as greenstones. The galena ores occur in a zone of fracture in the limestones, near the contact with some of the schistose greenstones. Within this zone they are irregularly distributed in masses and blebs. The galena carries gold and a large amount of silver.

Some galena deposits have also been found in the western part of Seward Peninsula, in the Lost River and Brooks Mountain regions.[2] These occur in shattered zones which traverse limestones of early Paleozoic age. Some of them are clearly contact-metamorphic deposits of granite and limestone; others are more or less intimately associated with quartz porphyry dikes.

No deposits valuable for their zinc contents have been found in Alaska. As has been noted in the preceding pages, sphalerite is a common accessory mineral in the gold, silver, and some of the copper deposits.

TIN AND TUNGSTEN.

Cassiterite in the form of stream tin is not an uncommon mineral in the auriferous gravels of the Yukon-Tanana region and Seward Peninsula, but its only known occurrences of possible commercial value are limited to the York region, in the western part of Seward Peninsula. Stream tin, however, forms a considerable percentage of the concentrates from the sluicing operations on some of the placer mines on tributaries of Patterson Creek, in the Hot Springs district, of the Tanana Valley. Considerable stream tin, associated with wolframite, has also been found on Deadwood Creek,[3] in the Birch Creek district. Scheelite, another tungsten mineral, has been found both in some of the auriferous gravels and in some small quartz veins on Seward Peninsula.

The only lode-tin deposits of which there is definite knowledge are those found in the western part of Seward Peninsula. Contributions to the knowledge of these lode and placer tin deposits have been made by several geologists,[4] but the following statements are

[1] Smith, P. S., and Eakin, H. M., A geologic reconnaissance in southeastern Seward Peninsula and the Norton Bay-Nulato region: Bull. U. S. Geol. Survey No. 449, 1911, pp. 130-133.

[2] Knopf, Adolph, The mineral deposits of the Lost River and Brooks Mountain regions of Seward Peninsula: Bull. U. S. Geol. Survey No. 345, 1908, pp. 268-271.

[3] Johnson, B. L., Occurrence of wolframite and cassiterite in the gold placers of Deadwood Creek, Birch Creek district: Bull. U. S. Geol. Survey No. 442, 1910, pp. 246-250.

[4] Brooks, A. H., A new occurrence of cassiterite in Alaska: Science, new ser., vol. 13 No. 328, p. 593; A reconnaissance of the Cape Nome and adjacent gold fields of the Seward Peninsula, Alaska, 1900, a special publication of the U. S. Geol. Survey, 1901, pp. 132-139. Collier, A. J., A reconnaissance of the northwestern part of Seward Peninsula, Alaska: Prof. Paper U. S. Geol. Survey No. 2, 1902, p. 49; Tin deposits of the York region, Alaska: Bull. U. S. Geol. Survey No. 229, 1904. Hess, F. L., The York tin region: Bull. U. S. Geol. Survey No. 284, 1906, pp. 145-157. Knopf, Adolph, Geology of the Seward Peninsula tin deposits: Bull. U. S. Geol. Survey No. 358 1908.

based almost entirely on the report of Knopf, who has made a more exhaustive study of this field than anyone else.

The York region, as here defined, comprises an area about 50 miles in width, including the west end of Seward Peninsula. A series of more or less altered argillitic slates, which contain much arenaceous material, comprise the oldest rocks of the field. (See

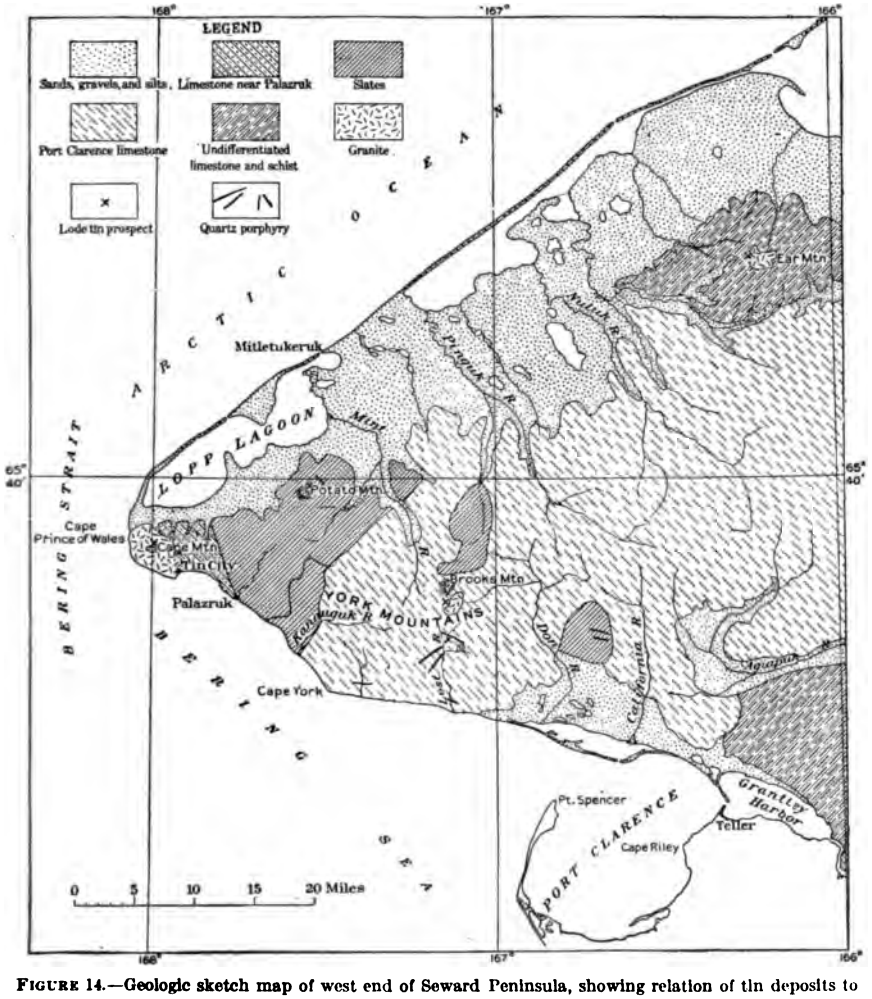


FIGURE 14.—Geologic sketch map of west end of Seward Peninsula, showing relation of tin deposits to intrusive rocks. By Adolph Knopf, 1907.

fig. 14.) These appear to be overlain on the east by heavy unaltered limestones of early Paleozoic age. On the west they are faulted against some crystalline limestones and schists, which are of Carboniferous age. Greenstones occur in the slates, and granites and quartz porphyry dikes cut all the formation. Knopf [1] summarizes

[1] Op. cit., p. 64.

the different types of cassiterite-bearing lodes, which in the slates are genetically related to intrusive granites, as follows:

1. In a tourmaline-axinite hornfels.
2. In beds of actinolite rock which are probably interstratified with slates.
3. In tourmalinized margins of granite masses and granitic dikes.
4. In mineralized quartz porphyry dikes.
5. In quartz veins cutting granite and accompanied by impregnation of the adjoining granite.
6. In quartz stringers cutting slates and limestones.

These deposits carry a large number of mineral species, which it is not worth while to enumerate here. Among the tungsten minerals wolframite and scheelite are worthy of note.

The cassiterite and wolframite of the alluvium in Deadwood Creek have been traced by Johnson[1] to a granite-schist contact zone, and prospectors report a small vein carrying these minerals in the vicinity. Johnson has listed the following minerals as occurring in the concentrates from this alluvium: Wolframite, cassiterite, magnetite, ilmenite, arsenopyrite, pyrite, galena, limonite, garnet, tourmaline, and quartz. The other creeks in the Yukon-Tanana region which have yielded stream tin all lie in areas of granite intrusions.

IRON.

In the absence of any development of the coking coals and the lack of transportation, there has been little encouragement to prospect Alaska's iron ores. Therefore there are few data on which to base conclusions regarding their geologic occurrence. Three types of iron-ore deposits have been recognized—(1) iron ores lying in the zones of igneous metamorphism, due to intrusion and to be classed as contact ores; (2) vein deposits; (3) deposits of magmatic segregations. The occurrence of magnetite in the contact zones of limestones and other sediments and intrusive rocks has already been noted in the description of the copper deposits with which these iron ores are associated (pp. 74–79). The best known of this type of magnetite deposits are those of Prince of Wales Island. Of these occurrences the Wrights[2] say:

> At the copper mines in Kasaan Peninsula magnetite forms about half of the ore mass and occurs in large amounts in some of the deposits in the vicinity of Hetta Inlet. * * * At several places on Prince of Wales Island magnetite occurs in masses sufficiently high in grade to make an iron ore, though no attempt has been made to mine it as such.

No analyses are available of these magnetite ores, but similar types of deposits have been mined on Tuxedo Island, in British Columbia,

[1] Johnson, B. L., Occurrence of wolframite and cassiterite in the gold placers of Deadwood Creek, Birch Creek district: Bull. U. S. Geol. Survey No. 442, 1910, pp. 246–250.

[2] Wright, F. E. and C. W., The Ketchikan and Wrangell mining districts, Alaska: Bull. U. S. Geol. Survey No. 347, 1908, p. 89.

and these have an average of 55 to 60 per cent of metallic iron,[1] while the phosphorus content of most of them is low enough to make them fall within the Bessemer limit. The sulphur content, however, is high. Magnetite occurs in similar geologic association on Prince William Sound, in the Iliamna region, and in the Nabesna region, as well as elsewhere in Alaska.

So far few examples of the vein type of iron deposits have been found. Schrader[2] described a magnetite ore body which appears to be a vein in the Nabesna region. This vein is well defined and occurs at a contact between limestone and diabase. Grant and Higgins report the occurrence of hematite and magnetite bearing veins in the Prince William Sound region.

Iron-ore deposits of the segregated type occur near Haines, in southeastern Alaska, but their commercial value remains to be established. These, according to Knopf,[3] consist of primary magnetite disseminated in a basic rock composed of pyroxene and hornblende. The best specimens seen carried a maximum of 30 per cent of magnetite. A microscopic examination showed the presence of apatite and the analysis of one sample showed 3.91 per cent of TiO_2.

Chromite occurs near Port Chatham, on Kenai Peninsula.[4] The country rock is a peridotite, composed essentially of olivine, which contains small grains of chromite. In places the chromite is abundant and is segregated in small bands, and these form the ore deposits.

ANTIMONY.

Stibnite, the sulphide of antimony, is one of the most widely distributed ores in Alaska. As has been noted, it occurs as an accessory mineral in many of the ore bodies of types already described. It remains to give an account of the occurrence of stibnite-bearing lodes in which the stibnite is the dominating metallic mineral. In all these occurrences the stibnite-bearing lodes carry more or less gold, and a number of them probably carry enough gold to warrant classifying them with the auriferous lodes.

In southeastern Alaska stibnite has been recognized only as an accessory mineral in some of the gold ores. Grant and Higgins[5] have described an occurrence of stibnite on Port Wells, Prince William Sound. At this locality there is a zone of brecciation along a fault

[1] Lindeman, Elmar, Iron-ore deposits of Vancouver and Tuxedo Islands, British Columbia: Pub. No. 47, Canada Dept. Mines, Mines Branch, Ottawa, 1910.

[2] Mendenhall, W. C., and Schrader, F. C., Mineral resources of the Mount Wrangell district, Alaska: Prof. Paper U. S. Geol. Survey No. 15, 1903, pp. 65–66.

[3] Knopf, Adolph, The occurrence of iron ore near Haines: Bull. U. S. Geol. Survey No. 442, 1910, pp. 144–146.

[4] Grant, U. S., and Higgins, D. F., Preliminary report on the mineral resources of Kenai Peninsula: Bull. U. S. Geol. Survey No. 442, 1910, pp. 168–169.

[5] Grant, U. S., and Higgins, D F., Reconnaissance of the geology and mineral resources of Prince William Sound, Alaska: Bull. U. S. Geol. Survey No. 443, 1910, p. 78.

line which cuts across the country rock of black slate and graywacke. These sediments are cut by acidic dikes in the vicinity. The stibnite ore occurs in a band of vein quartz along the hanging wall of the shear zone. No other minerals were noted in this deposit. Grant and Higgins[1] also report the occurrence, near Kenai Lake, north of Seward, of a fine-grained sheared acidic dike which contained particles and stringers of stibnite. Of the stibnite in the Fairbanks district Prindle[2] says:

> Stibnite was common in the concentrates from the placers in the early days of mining in the Fairbanks district and was afterward found in place in the bedrock at several localities in widely different parts of the district. It occurs in place here and there in the drainage area of Cleary Creek, and, together with arsenopyrite, accompanies the gold in the richest of the quartz veins. It has been found as narrow stringers composed almost entirely of massive stibnite crosscutting quartzite schist or forming a network of stibnite veins between fragments of brecciated schist; in veins of quartz and stibnite, where the massive stibnite occupies the spaces left between quartz crystals; and as fine needle-like crystals or small crystalline groups along with some fresh, clear quartz areas in more or less fractured quartz veins. At one locality stibnite was found in close association with a sericitized dike of granite porphyry. The schist had not only been intruded by the dike but had apparently been fractured by it. Stibnite has been deposited on the surface of the dike and occurs as small veins and lenticular masses up to several pounds in weight in the schist. The stibnite at this locality is apparently in close genetic association with the granite porphyry.

A ledge carrying stibnite has also been found on Caribou Creek, in the Kantishna district.[3] Here the stibnite is intergrown with quartz in a vein lying parallel to the foliation of the country rock, which is a hornblende schist. Antimony-bearing ledges are known to have been found on Seward Peninsula, in the Nome River basin and on upper Fish River. On Manila Creek, a tributary of Nome River, there is a well-defined quartz vein through which stibnite is disseminated. The country rock is schist, but the vein occurs near a limestone-schist contact.[4] At the Omilak mine,[5] in the Fish River basin, stibnite occurs in a shattered zone in a limestone bedrock. This limestone, which forms a belt almost one-fourth of a mile wide, bounded on both sides by schist, is cut by an altered intrusive rock.

OTHER METALLIC MINERALS.

Nickel and cobalt deposits have been reported by prospectors, but in no samples tested by the Survey were these metals found in commercial quantities. A small amount of nickel and traces of cobalt were found by the analyses of some pyrrhotite ores from the Ketchi-

[1] Grant, U. S., and Higgins, D. F., Preliminary report on the mineral resources of the southern part of Kenai Peninsula: Bull. U. S. Geol. Survey No. 442, 1910, p. 178.

[2] Prindle, L. M., Auriferous quartz veins in the Fairbanks district: Bull. U. S. Geol. Survey No. 442, 1910, p. 221.

[3] Prindle, L. M., The Bonnifield and Kantishna regions: Bull. U. S. Geol. Survey No. 314, 1907, p. 219.

[4] Moffit, F. H., The Nome region: Bull. U. S. Geol. Survey No. 314, 1907, p. 139.

[5] Smith, P. S., and Eakin, H. M., A geologic reconnaissance in southeastern Seward Peninsula and the Norton Bay-Nulato region: Bull. U. S. Geol. Survey No. 449, 1911, pp. 64–131.

kan district.[1] Similar tests on pyrrhotite ores from Prince William Sound revealed neither cobalt or nickel.

No commercial bodies of molybdenite have been found. In the Juneau district this mineral is found in some of the auriferous deposits which occur in the dioritic rocks, notably at the Treadwell mine. Molybdenite has also been found in quartz stringers which cut the sediments altered by igneous metamorphism adjacent to the Coast Range granite belt in the Ketchikan district. It has also been seen as an accessory mineral with the gold ores in other parts of Alaska.

A deposit of native bismuth on which a little development work has been done occurs on Charley Creek, tributary to Sinuk River, about 25 miles north of Nome. The bismuth occurs in two small quartz veins cutting a schist bedrock.

A cinnabar deposit was discovered near Kolmakof, on the Kuskokwim, many years ago and is a perennial source of attraction to prospectors. This deposit has not been studied by members of the Survey. Spurr,[2] however, notes that these veins cut shales of Mesozoic age, which have been intruded by acidic dikes. Cinnabar is found as an accessory mineral in some of the auriferous gravels. This mineral is very abundant in the concentrates from placer mining on Daniels Creek, about 60 miles east of Nome. While the bedrock source of this cinnabar has not been found, it evidently lies close at hand in a contact zone of schist and limestone.

A few minute grains of platinum have been found in some of the Alaskan gold placers, but nowhere in sufficient quantity to be of commercial importance.

[1] Wright, C. W., and F. E., The Ketchikan and Wrangell mining districts, Alaska: Bull. U. S. Geol. Survey No. 347, 1908, p. 87.

[2] Spurr, J. E., A reconnaissance in southwestern Alaska: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 7, 1900, pp. 261-262.

MINING IN SOUTHEASTERN ALASKA.

By ADOLPH KNOPF.

INTRODUCTION.

Southeastern Alaska has long held the world's record for the production of low-grade gold ore, a position due in the past mainly to the output of the Treadwell group of mines on Douglas Island. These mines are operating on a mineralized dike of albite diorite—a type of ore body of which this is so far the only one exploited in the region. On the mainland there exist behind the town of Juneau enormous bodies of low-grade ore, consisting of slate irregularly cut by auriferous quartz stringers. Mines have been operating on these ore deposits at a profit for a number of years, and the mining and milling costs have even been brought below those existing at Treadwell, but because of the disadvantageous situation of the mines several miles from tidewater the ore bodies have never been exploited on a scale commensurate with their magnitude. Plans have been formulated for their extensive development, but the execution of these large projects has necessarily been slow. Construction, however, was actually started in the later part of 1910, and it now appears that several hundred additional stamps will be dropping in the Juneau region in 1912. It is safe to say that, with this increase of milling capacity and the new developments contemplated or in progress at Douglas Island, Berners Bay, and Chichagof the gold production of southeastern Alaska will at least be doubled within a few years.

In contrast to this marked expansion of the gold-mining industry the copper-mining industry shows a stationary condition, nor with the prevailing low price of the metal is there likely to be any greatly increased output of ore.

Marble continues to attract attention as one of the mineral resources of southeastern Alaska. Prospecting continues and claims are located at widely separated localities, as at Dall Island, on the west coast, and at Limestone Inlet, 25 miles south of Juneau, and the productive quarries are enlarging their capacity.

GOLD MINES AND PROSPECTS.

PRODUCTION.

According to preliminary estimates, the production of gold for 1910 in southeastern Alaska was substantially the same as that for 1909, in round numbers $4,000,000. The following table gives the tonnage and value for a number of preceding years. It shows clearly the preponderant influence of the low-grade ores of the Juneau district on the average value per ton:

Production of gold ore in southeastern Alaska.

Year.	Ore mined.	Gold.		Silver.		Average value per ton.
		Amount.	Value.	Amount.	Value.	
	Tons.	*Ounces.*		*Ounces.*		
1907	1,206,639	132,300	$2,734,885	22,203	$14,653	$2.28
1908	1,475,516	161,975	3,348,312	31,834	16,872	2.28
1909	1,478,429	198,285	4,098,900	27,481	14,290	2.78

JUNEAU AND BERNERS BAY REGIONS.

DOUGLAS ISLAND.

The steadily increasing depth from which ore is extracted at the Treadwell group of mines has made advisable an enlargement of the hoisting capacity. In order to realize the economies of a central hoisting plant, it has been decided to make the shaft of the 700-foot claim the main hoisting shaft of the three mines that are grouped on the same lode—the Alaska-Treadwell, the 700-foot, and the Alaska-Mexican. A contract has been let for a balanced hoist capable of lifting 5,000 tons from a depth of 3,000 feet in 20 hours, the net load being 8 tons. A new gallows frame will be erected and new crushing machinery of heavier capacity installed. It is anticipated that the entire plant will be ready for operation by the fall of 1911.

The hydroelectric plant at the mouth of Sheep Creek, which is capable of generating 2,500 horsepower for about two-thirds of the year, and the transmission line to Treadwell were completed during the year. Work was started on a transmission line from Treadwell to Nugget Creek at Mendenhall Glacier, a distance of 12 miles, where it is proposed to build a dam, probably 125 feet high, which will have a storage capacity equivalent to approximately 5,000 horsepower for 90 days. When this project is completed, it will be possible to run the 300-stamp mill of the Alaska-Treadwell the entire year. At present it is shut down during the winter months on account of lack of water power.

prospect has been developed by a drift tunnel 30 feet long and by stripping of the ledge along the outcrop for several hundred feet.

SITKA AND KETCHIKAN MINING DISTRICTS.

The only active gold mines in the Sitka district are the Chichagof (locally known as De Groff) and Golden Gate mines. They are situated at the head of Klag Bay, on the west coast of Chichagof Island, 50 miles north of Sitka. Both mines are operating on what is presumably the same lode and are extracting a comparatively high-grade ore. The De Groff mine and mill are situated near sea level and the Golden Gate mine at 1,000 feet altitude, but the mill has been built at tidewater.

At the De Groff mine the present milling plant, consisting essentially of two batteries of two 850-pound stamps each and an edge-runner mill of the Chili type, proved to be inefficient and subject to vexatious delays, and in consequence it was decided to erect a new 10-stamp mill with heavier stamps and standard equipment. The ore milled during the year came from the rich ore shoot developed by the raise from the adit level to the upper tunnel; this ore was found to have a greater strike length than was indicated by the earlier workings.

On the Golden Gate property the stamp mill and aerial tram were completed and the milling of the ore commenced. The mill has been built for 10 stamps, but only 5 have been installed. The ore milled was mainly that which had accumulated on the dump during the early development of the mine and was rather medium or low grade. Underground development was continued, and an ore shoot comparable in value to those of the De Groff mine was reported to have been encountered late in June.

In the Ketchikan district several hundred feet of tunnel were driven on the proposed 1,600-foot crosscut tunnel at the Lon-de-Van group, which is situated on the north shore of George Inlet. This tunnel, which commences at the beach, is projected to undercut the ore body exposed at 900 feet above sea level.

Development continued on the Julia claim at Hollis until September, when the mine was shut down. Late in the year a small force of men was put to work on the Goldstream property on Gravina Island, 3 miles from Ketchikan, with a view to reopening the property. The main work done consisted of drifting on the 50-foot level. It is proposed to conduct experimental treatment of the ore to find a process that will give an economic extraction of the values, which have hitherto proved not readily amenable to ordinary stamp-milling practice.

COPPER MINES AND PROSPECTS.

GENERAL STATEMENT.

During 1910 copper ore was shipped from four mines, three of which are situated on Kasaan Peninsula and one on Hetta Inlet. They are all on Prince of Wales Island, in the Ketchikan mining district.

The main productive properties, as is well known, are located upon contact-metamorphic ore bodies, which commonly occur at or near the contact of limestone with intrusive masses of dioritic rocks. The ore is confined to the limestone and occurs in deposits of irregular shape and value. Many of the bodies are rich, consisting of masses of nearly solid copper mineral. These are easily exploited and a considerable tonnage of high-grade ore is rapidly extracted. They are then found to be surrounded on all sides by barren gangue material consisting either of magnetite, or crystalline limestone, or masses of lime silicates such as garnet, epidote, and pyroxene. The problem is then to find more ore. Inasmuch as the ore masses are without walls or other features that usually serve as guides in the search for new ore, the problem is difficult and no consistent or systematic method of development work has yet been evolved. At two of the mines diamond drills have now been installed to expedite the exploration for more ore.

A fear seems to exist in the district that ore will not persist in depth. Exploration work has been mainly in the lateral directions at comparatively shallow depths. Deeper development has perhaps been retarded by the apprehension that the ore will not go down. This fear appears to the writer to be groundless. It should be borne in mind, however, that although the ore bodies are likely to persist downward their distribution within the ore-bearing zone will be as irregular and erratic in depth as it is in the upper levels. This is no peculiarity of the Alaskan deposits but is common to all ore bodies of contact-metamorphic origin. Inasmuch as the primary sulphide chalcopyrite—the only cupriferous mineral in the ore—outcrops at the surface and, furthermore, as the origin of the ore bodies is independent of any relation to the existing topography, there is no reason to anticipate that the ores on the average will become richer in depth.

These deductions follow purely from the geologic evidence. The record of actual producing mines affords welcome data as to the possibilities of this type of ore deposit at increasing depth. On Texada Island, British Columbia, ore bodies of contact-metamorphic origin persist to a depth of at least 1,000 feet and the values in copper, gold, and silver hold in the bottom levels. At the Jumbo mine, on Hetta Inlet, in the region under discussion, the vertical range throughout which bodies of ore are known to occur exceeds 700 feet.

On the whole it can be said that the past record of the main producing mines on Prince of Wales Island shows that the masses of ore are encountered within the ore-bearing zone in sufficient number to maintain a profitable production; that this will continue in depth seems probable enough to justify in some mines a more systematic method of development than has yet been attempted. Extremely long adit levels that aim to undercut the ore-bearing zones at depths of more than several hundred feet, however, are inadvisable, on account of the proved capricious character of contact-metamorphic zones.

PRODUCTION.

The production of copper ore in southeastern Alaska during 1910, as shown by a preliminary estimate, is 2,250,000 pounds, which is less than that of 1909. The output for a number of preceding years is shown in the following table:

Production of copper ore in southeastern Alaska.

Years.	Ore mined.	Copper.		Gold.		Silver.		Average value per ton.
		Amount.	Value.	Amount.	Value.	Amount.	Value.	
	Tons.	*Pounds.*		*Ounces.*		*Ounces.*		
1907	79,982	4,758,814	$951,761	3,384	$69,960	44,196	$39,143	$12.14
1908	43,215	3,260,399	430,372	2,213	46,310	24,648	13,063	11.10
1909	28,491	2,705,988	351,778	1,946	40,228	16,679	8,641	14.06

KETCHIKAN MINING DISTRICT.

KASAAN PENINSULA.

The Mount Andrew mine, which is operating on a contact-metamorphic ore consisting essentially of chalcopyrite in a gangue of magnetite, maintained its usual annual production and in addition undertook some important new development work. The main supply of ore was obtained from stopes 2 and 4. Considerable drifting was done on the 50-foot level and good ore was encountered at several places. A raise was put through from this level to ore shoot No. 4, from which a large tonnage of rich ore has been extracted in the past and which is now being stoped downward from the main adit level, tunnel No. 1. A new tunnel, known as No. 2, was started several hundred feet northwest of No. 1, undercutting the outcrops at a depth of 100 feet, and enough ore was encountered to continue prospecting. The most noteworthy development work commenced during the year was that done on the new tunnel, designated No. 3, which, commencing at the old camp, is projected to undercut the ore body 300 feet below the present working level. The length will be 1,600 feet; 100 feet had been driven by the end of September.

At the It mine operations for the year commenced early in April. The main ore bodies lie in an embayment of limestone in an intrusive mass of diorite. The limestone has been coarsely recrystallized and more or less converted into lime-silicate rock. The ore consists of chalcopyrite in a gangue of calcite; the silicates, consisting of garnet, epidote, pyroxene, and others, contain only a small amount of copper mineral irregularly scattered through them. Development is proceeding on three levels below the working tunnel, the lowest being at a depth of 150 feet. From these levels the surrounding territory is being carefully prospected by diamond drilling.

At the Dean, a newly discovered prospect not far from the It mine, a tunnel 100 feet long was driven and a shallow winze was sunk 50 feet in from the portal. The ore is of typical contact-metamorphic type and consists of chalcopyrite in a gangue of coarsely crystalline pinkish calcite, associated with varying amounts of garnet, pyrite, and hematite. Several hundred feet northeast of this tunnel another has been driven approximately 75 feet long in a mass of lime-silicate rock.

Operations were resumed late in March at the Goodro mine after the winter shutdown. The main development undertaken consists of a winze sunk a depth of 100 feet below the tunnel. From the bottom of the winze drifts were driven both east and west and aggregate 150 feet in length. The winze is said to have been sunk in ore for 45 feet—that is, bornite in a heavy gangue composed essentially of pyroxene and biotite, with some feldspar and epidote. In the bottom level, which is 200 feet below the outcrop, some finely disseminated chalcocite and native copper were encountered. A width of 14 feet of this kind of ore is said to have been crosscut. All work was suspended after the middle of September, but it is planned that future exploration shall be done by diamond drilling. The discovery of chalcocite at a depth of 200 feet shows that the process of secondary sulphide enrichment has gone far deeper than would have been considered probable in this highly glaciated region. No such enrichment has affected the contact-metamorphic deposits, and this occurrence is therefore the more surprising.

HETTA INLET.

The only property on Hetta Inlet productive during 1910 was the Jumbo mine of the Alaska Industrial Co. This mine is the largest producer of contact-metamorphic copper ore in Alaska. The ore is mainly derived from the upper levels, in which there still remains a large amount of unexplored territory. In the stope on tunnel No. 4, the working tunnel and deepest level, a vertical diamond-drill hole was put down 130 feet and ore was encountered, proving that at this property the contact-metamorphic ore has a vertical range of at least 700

feet. On the level of tunnel No. 1 the ore-bearing zone is being explored southeastward by diamond drilling. A tunnel, projected to be 5,000 feet long and to undercut the ore bodies at 1,500 feet depth, has been started from tidewater, but work on it is not being pressed.

At the Red Wing mine it was reported that a crew of 12 men were employed in sinking a new shaft, planned to be 500 feet deep. This was the only other mining activity of note on Hetta Inlet during the year.

OTHER LOCALITIES.

At Big Harbor, near Klawak, on the west coast of Prince of Wales Island, the Northland Development Co. is said to be prospecting an ore body 62 feet wide and has driven an aggregate of 400 feet of drifts and tunnels. The ore was reported to consist of chalcopyrite in a lime gangue, but the samples shown to the writer proved to be a highly siliceous sericitic schist carrying disseminated chalcopyrite and pyrite. Some ore rich in black zinc blende was seen that came from the same locality.

At Seal Bay, on Gravina Island, the main crosscut tunnel has now attained a length of 1,700 feet, but driving ahead has been suspended. Eight quartz-chalcopyrite veins are reported to have been crosscut; at present the vein known as No. 3 is being drifted on and shows 5 feet of ore running 2 per cent in copper.

Late in the year a crew of six men was employed at the Rush & Brown mine, which is situated near the head of Karta Bay, on Prince of Wales Island. The mine was unwatered and preparations were made to get out a shipment of ore.

Development work continued at a number of other copper prospects scattered throughout the Ketchikan district, such as the Yellowstone group, on Dall Island; the Veta group, at Mallard Bay, near the south end of Prince of Wales Island, and others; but no operations of any considerable magnitude are to be recorded.

It is reported that work was resumed by a small force of men on the Moonshine vein, on the South Arm of Cholmondeley Sound. The values in this property are silver and lead, and it is one of the few of its class in southeastern Alaska.

THE EAGLE RIVER REGION.

By ADOLPH KNOPF.

INTRODUCTION.

The Eagle River region as defined in this report embraces the portion of the Juneau gold belt extending from Berners Bay on the north to Salmon Creek on the south. A topographic map of this region on the scale of 1 mile to the inch was commenced by J. W. Bagley in 1909 and finished in May, 1910. The accomplishment of this work completed the detailed mapping of the northern portion of the Juneau gold belt, which contains all the important mines and most of the prospects under development. The Juneau and Berners Bay maps have already been issued, and the map of the intervening territory is now in course of preparation.

Detailed geologic examination of the region has succeeded the topographic mapping. Detailed reports are available on the geology and ore deposits of the Juneau and Berners Bay regions.[1] The present report, which is based on work done during parts of the field seasons of 1909 and 1910, aims to give in summary form the essential geologic features of the Eagle River region. A detailed report is now being prepared.

GENERAL GEOGRAPHY.

The gold belt consists of a narrow strip of country lying between the high peaks of the Coast Range and salt water. The general trend is northwest and southeast; the length of the belt as measured from Salmon Creek, which is 3 miles northwest of Juneau, to Berners Bay, on the north, is 32 miles; the width ranges between 4 and 5 miles.

The region is one of abrupt topographic features which increase in ruggedness toward the northeast. Here the numerous glaciers and precipitous relief make the mountains nearly inaccessible. The drainage of the region is mainly longitudinal, but the larger streams, like Eagle and Mendenhall rivers, which are of glacial origin, flow across the general trend of the belt.

[1] Spencer, A. C., The Juneau gold belt, Alaska: Bull. U. S. Geol. Survey No. 287, 1906. Knopf, Adolph Geology of the Berners Bay region, Alaska: Bull. U. S. Geol. Survey No. 446, 1911.

Gastineau Channel and Lynn Canal bound the region on the southwest, so that it is easily accessible by water, but owing to the facts that there are few good harbors and that the mountains rise directly from the coast, ingress to the interior of the belt is practicable at a few points only.

A well-built Government trail traverses the length of the belt and connects Amalga, on the head of Eagle River, with Juneau. This trail renders the extreme inland portion of the gold belt somewhat more accessible than it has been in the past, but for the transportation of heavy freight from Juneau the waterway is far more serviceable. The economical development of any mining property in the belt necessitates the building of a tramway to the nearest harbor, and this is the course that has been adopted at those places where any operations of importance have been undertaken.

GENERAL GEOLOGY.

The rocks of the region are arranged in belts striking parallel to the general trend of the gold belt. The dip is generally steep to the northeast.

Quartz diorite gneiss forms the northeast boundary of the belt. This rock, which in local speech is accurately enough known as granite, consists essentially of plagioclase feldspar (near labradorite), quartz, biotite, and hornblende, all of which are discriminable by the unaided eye. The gneissic structure, which is in part a primary structure but was produced mainly by the crushing of the component minerals of the diorite, toward the northeast grades into the massive granular texture characteristic of normal granitic rocks. Viewed broadly this gneissic belt, which is from 1 to 2 miles or more wide, forms the foliated margin of the quartz diorite core of the Coast Range.

A belt of schists adjoins the gneiss on the southwest. Its width ranges from 2 miles at Mendenhall Glacier to a few hundred feet at Berners Bay. The schists comprise a considerable variety of rocks, mainly of original sedimentary origin, and show a considerable diversity of mineralogic make-up. Biotite, garnet, and amphibole are the most common minerals of metamorphic origin that are easily distinguishable, and of these biotite is by far the most abundant and widespread. Coarsely crystalline white limestones are interstratified with the schists in small amount but are disproportionately conspicuous. Along the southeast side of Herbert Glacier a large volume of augite melaphyres is included in the schist belt. On glaciated surfaces the weather tinting shows that some of these rocks were originally conglomerates or breccias. The shapes of the fragments are well shown, and the fragments differ from one another

in that some are more thickly studded with augite phenocrysts than others.

The schists are in many places exceedingly contorted. They are most highly crystalline where they adjoin the diorite gneiss, but toward the southwest they grade imperceptibly into the clay slates and graywackes of the next belt of rocks. In fact the boundary between the schists and the slate-graywacke formation was arbitrarily fixed by determining the first appearance of visible flakes of biotite in the rocks as the diorite gneiss is approached.

At many places along the contact of the schists and gneiss the schists are extensively injected with dioritic dikes. The dikes possess a gneissic structure and lie parallel to the foliation and stratification of the schists; in places this interlayering is so thorough and the alterations induced so profound that it is impossible to tell what is diorite and what is schist.

South of Mendenhall Glacier the schists are intruded by numerous white granitic dikes of both coarse and fine grained varieties. Many of the dikes are contorted with the schists, but others cut across the folds.

The belt of slates and graywackes lying between the schists and the volcanic rocks (greenstones) paralleling the coast comprises the most important rocks in the region. Nearly all the ore deposits are located in it. This formation is typically displayed along the shores of Berners Bay and has been named the Berners formation.[1] Fossil leaves were found at that locality and indicate that the rocks are of Jurassic or Lower Cretaceous age.

The general strike of the rocks is northwest and southeast and the dip is almost invariably northeast, ranging from 20° to vertical. Angles of 40° to 60° are the most common. In places the rocks are acutely folded and the axes of the folds stand vertical, but no evidence of more extensive folding was procured. The cleavage in the rocks is generally parallel to their stratification, but discrepancies occur locally.

At Berners Bay the graywackes are intimately interstratified with the slates. Toward the south they become less abundant and are comparatively scarce south of Eagle River. At Auke Bay the graywackes are practically absent and the rocks consist of fissile black slates. The strata of graywacke, so far as observed, range to a maximum thickness of 80 feet.

The graywackes are gray or greenish-gray rocks of roughly schistose or massive structure. They are composed largely of grains of plagioclase feldspar and quartz, together with fragments of other minerals and rocks, embedded in an argillaceous cement. Except the glassy

[1] Bull. U. S. Geol. Survey No. 446, 1911, p. 17.

grains of quartz and the fragments of black slate, none of these constituents are recognizable by the eye. The fresh rock taken from mine openings is black, owing to the presence of finely disseminated carbonaceous material; that taken from the natural exposures is gray or mottled gray, because bleached by the action of the sunlight. The graywackes are far harder rocks than the soft slates interstratified with them.

With increase of argillaceous material in the graywackes the cleavage approaches in perfection that of the interbedded clay slates. Such rocks might be called graywacke slates. On cross-fractured surfaces some of them show only numerous glistening particles of quartz embedded in an aphanitic matrix.

Masses of volcanic rock form scattered areas throughout the belt of graywackes and slates. The most persistent development, however, is in the long belt fringing the coast from Point Bridget to Auke Bay. The volcanic rocks include lavas, flow breccias, tuffs and coarse breccias, and conglomerates. Clay slates are intercalated with them at some places, and it is a general rule that beds of fragmental igneous rocks alternate with normal sedimentary rocks near the margins of areas of dominantly volcanic rocks.

The characteristic feature of these rocks is the widespread prevalence in them of numerous well-formed and well-preserved augite phenocrysts set in a dark blue-green matrix of aphanitic texture. Feldspars are notably absent. Pending more complete petrographic investigation these rocks will be designated augite melaphyres, according to the descriptive field classification of Pirsson. In places they are extremely amygdaloidal; between Yankee Cove and Bridget Cove they display a striking ellipsoidal structure. The conglomerates consist essentially of volcanic material; the pebbles range from well rounded to angular; the matrix is tuffaceous or of volcanic origin, so that it is in many places impossible to discriminate conglomerates from breccias.

The bulk of the rocks show no schistose structure. The strike is northwest and southeast; the dip ranges from 20° N. at Auke Bay to vertical at Bridget Cove.

A considerable number and variety of dikes, mainly greenstones according to local usage of the term, are intrusive into the slates and graywackes, but with few exceptions all of them lie parallel to the stratification of the inclosing rocks. Dikelike masses of augite melaphyre, identical with the rock of the volcanic areas, are common, but whether they represent interbedded lava flows or intruded sills is determinable in few places. It is probable that both forms are present, but the distinction does not appear to be of practical importance. These sheets range from a few feet to 300 feet in thickness. They are hard massive rocks, but the contacts are, as a rule, thoroughly schistose.

Dikes of augite lamprophyre have a widespread distribution throughout the region, being found from Berners Bay on the north to Douglas Island on the south. They resemble the augite melaphyres in some respects but consist essentially of large augite phenocrysts embedded in a finely granular gray-greenish matrix. In some of these dikes augite crystals form the bulk of the rock; in the better-preserved specimens the augites are of fresh green vitreous appearance. Dikes up to 100 feet thick were noted.

Diorite porphyry dikes are found in the region south of Eagle River. Some of them, on account of their resistance to erosion, are unusually well exposed and form the beds of streams for several miles. These dikes are light-gray rocks consisting of white feldspar phenocrysts and scattered hornblende prisms set in a finely granular or dense groundmass. Some dikes of quartz diorite porphyry are found on the peninsula on the east side of Auke Bay.

A narrow belt of diorite 5 miles long extends south from Eagle River. This rock is of medium to fine grained granular texture and is composed of plagioclase feldspar, augite, and biotite. The feldspar is somewhat epidotized, and the rock tends to assume a green hue. This diorite differs considerably in appearance from the quartz diorite that occurs along the northeast margin of the gold belt, nor does it possess a gneissic structure. It probably represents a separate intrusion like the Jualin diorite at Berners Bay. A porphyritic diorite dike several hundred feet thick was traced for a distance of 7 miles southeastward from Eagle River along the hills flanking the east side of Peterson Creek. The rock carries numerous large tabular feldspars, which impart to it an individuality that distinguishes it from other dikes in the region.

ECONOMIC GEOLOGY.

The ore bodies are exclusively gold deposits. The great majority are stringer lodes; a few are fissure veins, and a number of mineralized dikes have been discovered.

Nearly all the ore bodies occur within the belt of slates and graywackes; a few are found in the quartz diorite gneiss; none of economic importance are known to occur in the belt of schists. The marginal portion of the slate-graywacke belt that adjoins the schists appears from present developments to be the longest zone of continuous mineralization in the district.

The ore bodies designated stringer lodes are belts of slaty or schistose rock cut by irregular quartz stringers. As a rule the ore bodies tend to follow the structure of the inclosing rocks, both in strike and in dip, but individual stringers commonly cut across the cleavage irregularly. Solid bodies of quartz are occasionally found and may apparently show the normal attributes of ordinary fissure

veins, but such masses of quartz are invariably found to fray out into stringer lodes along both strike and dip.

Many of these ore bodies can hardly be said to possess definite walls. At some places, however, the better ore is found to occur in slate that rests upon a footwall of graywacke; at other places mineralization has taken place in slate lying along a footwall of augite melaphyre. In general terms, an intercalated sheet of harder and more massive rock is likely to serve as footwall. Where this is so the melaphyre, which is usually referred to as greenstone, is more likely to form a continuous wall than the graywacke, for the graywacke beds are inclined to have a short lenticular structure and to be discontinuous along strike and dip.

Except for sporadic shoots of rich ore, the stringer lodes are of low grade. They range in width from a few feet to 100 feet and apparently at a few prospects to 300 or 400 feet. The greatest depth attained anywhere in the district does not reach 200 feet. The average value of a stringer lode is dependent upon the number and richness of the individual quartz stringers contained in the whole mass of slate. As a rule the quartz veinlets are leanly mineralized with sulphides, and these have a tendency to be massed in and around fragments of slate inclosed in the vein stuff. Arsenopyrite is the commonest sulphide, and pyrite, galena, pyrrhotite, and sphalerite are found in the order named, but as a rule all do not occur together in the same deposit. Free gold is rarely seen. Auriferous arsenopyrite running several dollars to the pound is found near Echo Cove, and the association of arsenopyrite and galena is everywhere accompanied by high values in gold.

The fissure veins differ from the stringer lodes in consisting essentially of narrow tabular masses of quartz. Only a few representatives of this class are known—not more than five—and all of them have this feature in common, that they cut across the stratification and cleavage of the inclosing rocks. One or both walls are generally marked by fault planes.

The mineralized dikes are few in number and from present development appear to be of little economic interest, but in the writer's opinion they are entitled to a somewhat more careful examination by the prospector than has been accorded to them. They were noted on the northwest side of Mendenhall Glacier and between Lemon and Salmon creeks, where they are about 30 feet thick. The dikes are dioritic in composition and dark colored but where mineralized have been changed to a white rock, which is cut by numerous veinlets consisting of quartz, albite, and dolomite. The principal sulphide is pyrite; galena and arsenopyrite are present in minor amounts. Rutile occurs in sporadic large crystals of adamantine luster but more commonly forms acicular aggregates in which the individual

needles lie at angles of 60° to one another. The smaller veinlets through the rock consist largely of albite, and where the structure is drusy this mineral is crystallized in typical feldspar forms. This highly interesting kind of mineralization is essentially similar to that which has affected the Treadwell dikes, a few miles to the south; unfortunately this mineralization was not everywhere accompanied by auriferous deposition of commercial value.

DEVELOPMENT.

The earliest operations in the region were those of placer miners on the heads of Montana and Windfall creeks in 1882. Old wing dams, ditches, and bowlder piles show where the pioneers labored, but because their efforts yielded a bare wage only, attempts at placer mining were soon abandoned. The first lode locations were made also in 1882 at Montana Basin and near Auke Lake. Prospecting has continued intermittently ever since. New discoveries are made from time to time and as late as 1908 extensive quartz croppings were uncovered near the point where the old trail crosses the summit between Auke Bay and Montana Creek. To those familiar with the region such discoveries occasion no surprise. Outcrops throughout the inland portion of the gold belt below timber line are effectually buried under several feet of glacial drift and this overburden is itself covered by a heavy growth of moss and vegetation. These features, together with the wet climate, render prospecting a difficult and onerous employment. It is therefore to be expected that occasional discoveries will continue to be made, aided as they have been in the past by the overturning and uprooting of trees and by the formation of landslides which from time to time bring to light new exposures of bedrock.

The state of development of the region in 1903 was described by Spencer[1] and in 1905 by Wright.[2] The development since that time has been far less rapid than was anticipated, and in view of the fact that a detailed report is in course of preparation, descriptions of individual properties are omitted in this preliminary account. Many causes have combined to retard the progress of the mining industry—litigation in some cases, inflated valuation in others—but principally the essentially low grade character of the ores. A large capital expenditure is necessary to open the properties, and such investments usually demand a more adequate development of the ore bodies than has so far been made in most places. Even at Juneau, where the ore bodies have had the advantage of being near a center of population, the formulation and adoption of plans for the working of the low-grade gold deposits on a scale proportionate

[1] Bull. U. S. Geol. Survey No. 287, 1906, pp. 117-134.
[2] Bull. U. S. Geol. Survey No. 284, 1906, pp. 34-37.

to their magnitude has required many years' time, and it is only recently that these plans have been nearing achievement.

The production of the region, with the exception of a few thousand dollars, has been the output of a single mine at Eagle River, which has been in operation since 1903.

PRACTICAL CONCLUSIONS.

The foregoing sketch of the geology presents only those features having a bearing upon the occurrence of the ores in this region. Some inferences of a practical character have already been pointed out. The most striking fact in the geology of the region is the almost complete restriction of the ore bodies to the belt of slates and graywackes. Although the ore bodies have been found distributed throughout the length and breadth of the area underlain by those rocks, they are nevertheless most numerous in the zone lying along the belt of schists. Moreover, the highest-grade ore yet found in the region and the only productive mine are in that zone. The conclusion is therefore obvious that those portions of the belt adjoining the schists that have not been adequately prospected are the most favorable fields for further investigation, notably the stretch between Windfall Basin and Eagle River, and possibly that between Mendenhall Glacier and Montana Basin.

In other parts of the slate-graywacke area the contacts with the intercalated masses of augite melaphyre, breccias, and conglomerates (rocks that are collectively known in the region as greenstone) appear to form favorable localities for mineralization. The masses of harder rock are apt to betray their presence, at least in parts of the region, by forming the bedrock of knobs or other topographic prominences.

A few small fissure veins have been found that break across the structure of the quartz diorite gneiss. The entire length of some of these veins is absolutely exposed on the bare glaciated surfaces and does not reach 200 feet; the width is a few inches. Although some of these veins contain considerable free gold, they nevertheless show a surprising lack of alteration of their wall rocks such as generally accompanies productive ore deposits. In view of this unfavorable feature and the short, narrow character of the veins, extensive sinking of shafts on them is a waste of time and energy. Where larger and longer ore bodies are indicated and the diorite is intensely altered by the action of vein-forming solutions, as on the flank of Mount Thane, further prospecting is to be encouraged.

The future of the district will, however, depend largely on the exploitation of the low-grade stringer lodes. The history of the mineral development of Silverbow Basin, at Juneau, will repeat

itself here. In early days attempts were made to mine some of the stronger veins found in the stringered zones of slate in Silverbow Basin, but owing to the nonpersistent character of these veins such attempts assured a precarious existence to the mines founded on them. By a natural evolution that is still going on methods have gradually been developed to mine and mill the whole mass of rock of the ore-bearing zone, and the practice has now settled down to exploiting ores ranging from $1.25 to $3 a ton in value. This is likely to be the course of development in the northern extension of the Juneau gold belt.

THE UPPER SUSITNA AND CHISTOCHINA DISTRICTS.[1]

By FRED H. MOFFIT.

INTRODUCTION.

A topographic reconnaissance survey of that part of the south slope of the Alaska Range and the adjacent lowlands between the latitudes of Delta River and a point a few miles west of Mentasta Pass was made by T. G. Gerdine in 1902. At the same time the geology of this region, which includes the placer gold deposits of Chistochina River, was studied by Mendenhall.[2] This paper describes the continuation of that work in 1910. An account of the field work on which it is based is given on page 10.

The descriptions that follow deal principally with the two placer gold fields commonly known in the Copper River region by the names of their most important gold-producing creeks—Valdez Creek and Slate Creek. These two fields lie in the foothills on the south side of the Alaska Range. They are about 75 miles apart and are associated here because of their geographic position and the fact that they were visited in the course of the same summer's work rather than because of similarity or relationship between them. The two districts are represented in Plate VII (p. 114).

Valdez Creek is a tributary of Susitna River from the east and joins it a little more than 15 miles south of the nearest of the several glaciers from which the Susitna rises. Slate Creek, on the other hand, is a tributary of Chistochina River, which in turn is a northern branch of Copper River and is one of the three largest streams draining that part of the Alaska Range included within the Copper River basin. Both districts lie within the foothills of the Alaska Range, and their principal gold-producing streams are just above timber line—that is, between 2,500 and 3,000 feet above sea level. Fortunately, however, they are so near timber that the supply needed for fuel and for mining is procured with little difficulty.

[1] This paper is a preliminary statement of the results of a geologic reconnaissance by the writer and B. L. Johnson in the upper Susitna and Chistochina districts in 1910; it will be followed at a later date by a more extended account of the upper Susitna district.

[2] Mendenhall, W. C., Geology of the central Copper River region, Alaska: Prof. Paper U. S. Geol. Survey No. 41, 1905.

The nearest shipping point on the coast is the town of Valdez, which is about 130 miles almost directly south of a point midway between Valdez and Slate creeks. Since the discovery of gold in these two districts all supplies required by the miners have been brought in over the military trail from Valdez in winter. Freight for both districts passes over the same route from Valdez to Gulkana, but at that point the winter trails separate. Supplies for Valdez Creek are taken up Gulkana River and one of its western branches to a low divide leading to Maclaren River. Thence they are carried down the Maclaren to the Susitna and up the Susitna to Valdez Creek. These trails will be described in more detail in the account of Valdez Creek.

From Gulkana supplies for Slate Creek are taken up the Copper and the Chistochina to the camps at the head of the latter stream. These two winter trails will be better understood by referring to the map (Pl. VII).

The military trail, which for 12 years has been the route of entrance to the Copper River valley, has been turned into a road, and it was possible at the end of the summer (1910) to take wagons all the way through to Fairbanks from Valdez. This improvement is a great benefit to all the region in touch with the road, and the members of the Alaska Road Commission and those working with them deserve much credit for what they have accomplished. There still remains a great deal to be done in the matter of bridges and ditching, but those who have traveled over the old trail and the new road can not fail to appreciate the progress that has been made. A road also has been cut through from Willow Creek, between Tonsina and Copper Center on the military road, to connect with the Copper River & Northwestern Railway at the mouth of Chitina River, and when the bridge over Tonsina River is constructed communication between the coast and the upper Copper River valley will be far easier than it has been. This road will undoubtedly draw considerable traffic away from Valdez but will avoid the delays and difficulties that are presented by Thompson Pass in the winter and spring.

In the matter of mail communication with the outside, the Chistochina region is more fortunate than Valdez Creek. Gulkana is the last post office south of the Alaska Range on the military road out of Valdez, but a second mail route between Gulkana and Dempsey (near the mouth of Chisna River) by way of Chistochina was in operation in the summer of 1910 and a regular bimonthly service had been established. There was no mail service between Gulkana and Valdez Creek. The miners on Valdez Creek, however, received letters and a limited number of papers from Gulkana by an Indian messenger who was paid by private subscription. It would seem as

if a summer service, which would benefit a greater number of people, could be established by carrying the mail from the coast to some point like Paxsons or Yosts on the Valdez-Fairbanks road, from which branch routes would connect with Slate Creek, 25 miles to the east, or with Valdez Creek, 65 miles to the west. Such an arrangement would make the most of the advantages offered by the military road, but these more northern branch trails, especially that to Valdez Creek, would hardly be practicable in winter, as both are above timber line and afford no wood for fuel.

Although, with our present knowledge of the facts, it is too much to say that the gold occurrences of Slate Creek and Valdez Creek are exactly alike, there are, nevertheless, many points of similarity between them. The source of the gold in both localities is in slates that have been intruded by diorite and related granular rocks. It has not been shown that the slates of the two localities are of the same age, and in fact it appears more probable that they are not, but the intrusions of the slate by the diorite are believed to be approximately contemporaneous, whatever their geologic age may be.

No well-defined and persistent auriferous veins have yet been found in the slates, although small gold-bearing quartz stringers and lenses are present. Nearly all the streams heading in the Alaska Range between Slate Creek and Valdez Creek have shown the presence of gold in their gravels, but in most places the amount has not proved sufficient to make mining profitable. The one possible exception is Rainy Creek, a tributary of Delta River below Eureka Creek, on the west side. Five men were at work there in 1910 and in the early part of the summer had some promising prospects but were hardly making wages at that time. Prospecting on Delta River above Eureka Creek and on Little Clearwater Creek has not been successful, yet gold is present in the gravels. Although gold is widely distributed in this part of the Alaska Range, deposits of commercial importance are localized and few in number. It would seem that the best places for prospecting are in the slate areas, for there is no reason to believe that gold is present in the basaltic rocks and the diorite areas do not yield gold, notwithstanding the fact that the diorite intrusives were most probably connected with the origin of the gold.

VALDEZ CREEK.

GENERAL STATEMENT.

Valdez Creek has been a producer of placer gold since 1903, but it was not visited by any member of the United States Geological Survey previous to the summer of 1910. For that reason and because the published descriptions of the stream are few and incomplete, it is desirable to make the present paper somewhat more com-

prehensive than would be necessary if the district had been fully described before.

Valdez Creek is approximately 14 miles long, but only a short stretch at its lower end yields placer gold at present (1910). Some of its tributaries, however, produce gold and others probably will do so in the near future. This creek, as previously stated, is a tributary of Susitna River. It rises in the mountain complex flanking the main Alaska Range and flows westward to the Susitna (Pl. VII). Its principal branch, Roosevelt Creek, heads in two small lakes that occupy the pass leading from Valdez Creek to Big Clearwater Creek and contributes nearly as much water to the main stream as does the upper part of Valdez Creek above the mouth of Roosevelt Creek. The two next largest feeders are Timberline and White creeks. Rusty Creek and Lucky Gulch are tributaries of White Creek and Roosevelt Creek, respectively. All these tributary streams are on the south side of Valdez Creek proper.

Valdez Creek flows through a strongly glaciated valley. South of it and around its headwaters are high, rugged mountains, but the mountains north of the lower or western end of the creek present smooth, rounded contours when viewed from the southern side, although the north slopes are precipitous. The valley is wider than most of the smaller stream valleys in the region to the east, especially at its lower end, where the valley of Valdez Creek joins that of Susitna River. This difference is pronounced, yet less so than that shown by the tributaries of Susitna River on the west side opposite Valdez Creek and to the northwest in the direction of Broad Pass. All the northern tributaries of Valdez Creek are comparatively unimportant, as regards both their present economic value as gold producers and the quantity of water they contribute to the main stream. They drain the smooth north slope of the valley and have cut deep gulches and canyonlike channels in its surface. The larger southern tributaries, on the other hand, occupy steep, strongly glaciated valleys and head in cirques that either contain the dwindling heads of old glaciers or were but recently vacated by them.

Valdez Creek has an abundant supply of water which is available for mines on the lower 4 miles of the stream and which can be secured with little difficulty and at small expense, considering the very high cost of supplies and equipment in this region. A rough measurement was made a short distance above the canyon for the purpose of obtaining data on which to base an estimate of the amount of water available for use below. This measurement, made at the end of August, showed from 3,000 to 5,000 miner's inches. These figures are, however, only a very rough approximation, and a long series of careful measurements should be made before installing any expensive plant to use this water.

TRAILS AND TRANSPORTATION.

The first miners on Valdez Creek came from Valdez by way of Valdez Glacier and the upper Klutina Valley. They crossed Klutina Lake on the ice, and after ascending St. Ann River to Hudson Lake they traveled north to the Susitna Lakes by way of Tazlina Lake, and then descended Tyone Creek to Susitna River, where they established a base camp and began their prospecting. During the first year or two of work on Valdez Creek supplies were brought from Valdez by this route, but it was then abandoned in favor of the better route by way of Gulkana, already described. All freighting is now done over the Gulkana trail. The smooth ice of Gulkana, Maclaren, and Susitna rivers gives a low-water grade for hauling that is practically continuous from Gulkana to Valdez Creek, for the divide between the Gulkana and Maclaren drainage, where crossed by the trail, is too low to be noticeable. The distance from Valdez to Gulkana is 128 miles and from Gulkana to Valdez Creek is approximately 125 miles. The cost of freighting from Valdez over this trail averages nearly 30 cents a pound (1910).

An attempt to establish a new winter route to the coast by way of Susitna River was not considered successful and has not been renewed. A few supplies, however, are brought in from Fairbanks each year by way of Nenana River and Broad Pass.

There is a choice of several routes for summer travel between Valdez Creek and the military road. The one usually followed is an old Indian trail from Bear Creek near the mouth of Gulkana River directly northwest to Valdez Creek, a distance of 105 miles. This trail is in timber all the way and has the disadvantage of being exceedingly wet in the open season. Another route, used only a few times, is from Paxsons to the west fork of Maclaren River and thence to Valdez Creek by way of the Roosevelt Lakes. This trail is about 65 miles long, but it is above timber line after it leaves Paxsons except in the vicinity of the Tangle Lakes and has another disadvantage in that it crosses a number of ridges, ranging in height from 500 to 1,000 feet above the valleys. The shortest and easiest trail is from Yosts, or some near-by point on the military trail, to Maclaren River by way of Eureka Creek, and thence to Valdez Creek by way of the Roosevelt Lakes. This trail is above timber except at Delta River. The only ridges of consequence which it crosses are between the forks of Maclaren River and between Maclaren River and Little Clearwater Creek, both of which can be avoided by a little labor in brushing out a trail. This northern trail, however, is very little shorter than that from Paxsons.

GENERAL GEOLOGY.

The statements that follow regarding the geology of Valdez Creek apply to the immediate vicinity of the creek (see fig. 15), yet the same geologic formations are widely distributed in the region both to the east and west.

Slate forms the bedrock of Valdez Creek throughout its length except for a short distance at the upper or east end. Locally the slate has been changed into schist. This change was brought about

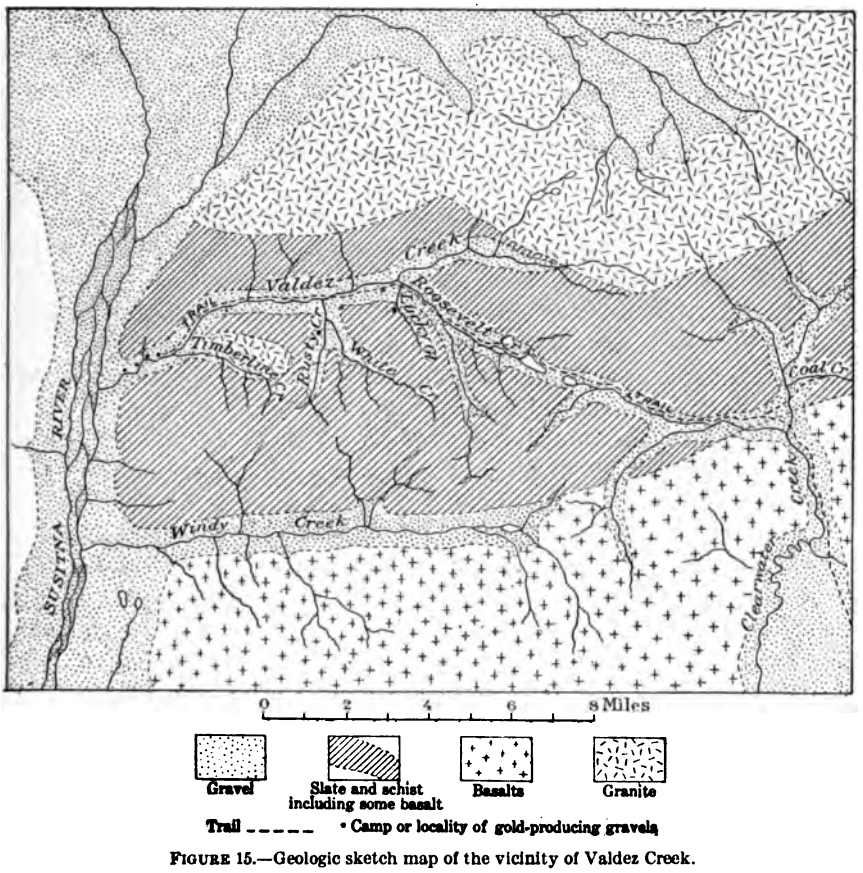


FIGURE 15.—Geologic sketch map of the vicinity of Valdez Creek.

by the intrusion of granite and related light-colored granitic and porphyritic rocks into the slates and by moderate folding, which probably took place during and after the time of granite intrusion. The slates are associated with limestone and shale beds that contain Upper Triassic fossils, but convincing evidence of their Mesozoic age is still lacking.

South of the slate area is a belt of dark basaltic rocks whose stratigraphic relation to the slates has not yet been determined

beyond question. The basalts have a bedded appearance and have undergone deformation that is shown by folding. They are best developed on Windy Creek.

The slate area is bounded on the north by diorite, which is exposed over a large area that includes the head of Valdez Creek and most of the ridge north of it. The diorite intrusions are younger than the slates but may possibly differ much in age among themselves, since there is a wide variation in the amount of metamorphism that has taken place in them. At the head of Valdez Creek part of the diorite appears to be fairly fresh and little altered, but in the ridge north of Valdez Creek the changes are great. The rock has a gneissoid structure and a pronounced cleavage, whose production was accompanied by the formation of such minerals as cyanite and garnet in the adjacent schistose sediments. Great alteration has taken place in the sedimentary rocks adjacent to the granite intrusions north of Valdez Creek, and the schistose character is highly developed there. Schistosity decreases as distance from the granite intrusion increases till it practically disappears in the slates south of Valdez Creek, although the regularity of the decrease is affected in some degree by smaller intrusive masses such as that on Timberline Creek.

The principal rock formations of the Valdez Creek vicinity, then, are the dark basaltic rocks of Windy Creek, the slates and schists into which the slates that occupy most of the Valdez Creek valley have been changed, and the granite that was intruded into the slates and is most widely exposed north of Valdez Creek.

The unconsolidated deposits of Valdez Creek consist chiefly of talus material that mantles the mountain slopes and the gravels that cover the valley floor. The gravel deposits include, of course, the present stream wash, but they are made up chiefly of bench deposits and are intimately associated in their origin with the glaciation of the valley. The rock fragments are chiefly slate and schist, with much associated igneous material. The gravels contain an uncommon proportion of large granite bowlders. During the period of maximum glaciation Valdez Creek valley and the adjacent Susitna Valley were filled with ice, but the Susitna ice stream was able to contribute to the gravels of lower Valdez Creek some rock foreign to the valley. A very important feature of Valdez Creek, in connection with the distribution of its gravel deposits, is the fact that the present stream channel is not the original channel. Before the present canyon was developed the creek had cut an earlier but shallower canyon in bedrock. This was overridden by ice from the north and east and filled with gravel, and when at last the ice disappeared and the creek established a new channel for itself, its new course did not coincide with its old one. The present canyon is cut into the slates 60 feet deeper than the old canyon at the place of their intersection on claim "No. 2

above" and is now 170 feet below the top of the benches on either side of the creek at that locality.

ECONOMIC GEOLOGY.

The placer gold of Valdez Creek has its chief source in the slate area south of the creek. This is fully proved by the results of prospecting on the tributary streams. The tributaries that flow into the main stream from the north have been found to carry only a small quantity of gold, not enough to encourage prospecting. On the other hand, all the gulches and creeks that cut the slates to the south carry gold, and in many places even the loose slide rock on the slopes yields a good string of colors on panning.

Among these southern tributaries Lucky Gulch has been a gold producer for several years and Rusty and White creeks give promise for the near future. There appears to be little doubt that the hill between Valdez Creek and White Creek extending east to Roosevelt Creek is one of the principal areas of mineralization, although it is not the only one. The slates are cut by light-colored igneous intrusives and by small quartz veins. Many of these quartz veins carry gold in sufficient quantity to encourage careful examination, yet little attention has been given to prospecting for lode deposits of gold in the district.

The total production of the Valdez Creek district is about $260,000. Mining operations in this district in 1910 were restricted to a few creek claims on Valdez Creek, to the Monahan tunnel, Lucky Gulch, and Rusty Creek. Assessment work was done on many other claims, but this was only to hold the property for future development.

The creek claims on Valdez Creek that have received most attention are "Discovery claim," "No. 1 below," "No. 2 below," "No. 2 above," and "No. 3 above." (See fig. 16.) "No. 1 above" includes a deep rock-walled canyon too narrow to permit mining. The richest of the productive claims were "Discovery claim," "No. 1 below," and the lower half of "No. 2 above." There is little variation in the character of the gravel on the creek claims. It ranges from 3 to 8 feet in thickness and consists of slate, schist, and granite, together with a small proportion of light-colored porphyritic intrusives and dark basaltic and tuffaceous material. An important characteristic of the gravel deposits is the great proportion of large granite bowlders. Such bowlders are difficult to handle in the cuts and add much to the cost of mining. Many of the larger ones are too heavy to lift with the ordinary means at hand and are moved only by undermining them on one side and causing them to roll over.

The gold in the creek claims shows considerable variation in its appearance. Part of it is flat and smooth, but another part is rough and little worn. Gold from the claims above the Monahan tunnel

shows less wear than that below. A large amount of "ruby sand" or garnet is associated with the gold, yet less "black sand" is present than might be expected from the quantity of igneous material contained in the gravel. A little more than one-third of the total gold production of Valdez Creek from 1903 to 1910 has come from these creek claims, but it is expected that their yield will be considerably less from now on, because so far as known most of their richest gravel has been mined out.

The Monahan tunnel is of particular interest, both geologically and because it has yielded more gold than any other single property in the district and nearly as much as all the others together. This tunnel follows the bottom of an old filled-in canyon in the slates, which

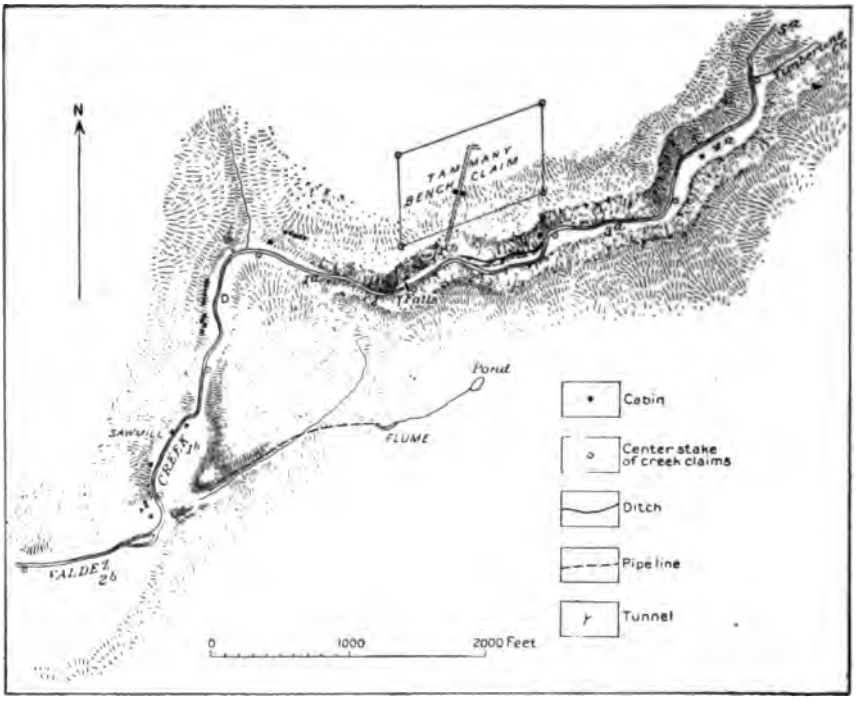


FIGURE 16.—Sketch map of part of Valdez Creek, showing placer-mining camps. D, Discovery claim 1a, claim "No. 1 above," etc.

makes an angle of about 45° with the present course of Valdez Creek at their point of intersection. It starts on claim "No. 2 above" at an elevation of approximately 60 feet above the present creek bed and is driven across the north half of the creek claim into the adjoining Tammany bench claim. (See figs. 16 and 17.) Its position south of Valdez Creek has not been determined. Its present length is about 700 feet. The course of Valdez Creek at the tunnel's mouth is east-northeast; that of the tunnel itself is north-northeast. The distance from the tunnel floor to the surface of the bench above is 110 feet,

which represents the depth of gravel filling in the old canyon, for on either side of the tunnel slate bedrock is seen outcropping within a few feet of the surface of the bench. The canyon is not straight, yet the variations in its course so far discovered are not important, unless the last abrupt turn to the east near the end of the present workings marks the beginning of a new course.

Bedrock in the tunnel is slate or schist. It is not fractured enough to permit gold to penetrate it far. Crosscuts from the tunnel, one about 100 feet to the west and one 60 feet east, show that the bedrock rises steeply on either side and that the walls are waterworn. The measurements in these crosscuts, however, do not indicate the general width of the canyon, for the tunnel in most places is at or near the canyon wall and the measurement of 100 feet is probably a maximum. In many places the width is much less than that.

There is no difference between the kind of rock material making up the gravel in the old canyon and that in the creek, but there are variations in its character. The lower 50 feet of gravel in the canyon contains flat granite bowlders with rounded edges, rounded slate and schist fragments, and fine black clay. Above this the canyon filling shows more of the large granite bowlders, but they are round rather than flat, the gravel is not so clean as below, and the whole deposit has an appearance of greater disorder.

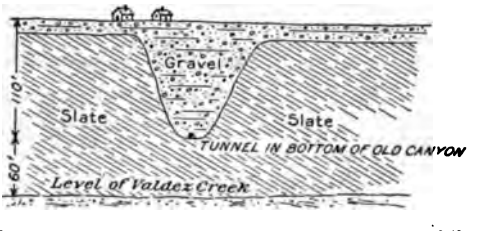


FIGURE 17.—Diagrammatic section showing relation of the Monahan tunnel to Valdez Creek. The old canyon intersects the present channel at an angle of 45° and is 60 feet above it.

Gold is found chiefly in the lower 5 feet of gravel, although there is fine gold in the upper part also. Most of it is contained in the hard black clay and fine rounded slate gravel. The gold is coarse, flattened, and smooth for the most part, yet a few rough nuggets, some of them containing quartz, are present. Although heavier, it much resembles the gold of the creek claims below.

If it should become desirable to apply hydraulic methods in the mining of these bench gravels, the favorable conditions for obtaining a good water supply and a dump for tailings are to be noted.

Aside from the Monahan tunnel, mining operations were conducted in the bench gravels of this creek at one other locality. A small tributary joins Valdez Creek at the upper end of claim "No. 2 below." It drains a slight depression southeast of the main creek and at its upper end is probably not over 175 feet above the creek. At its lower end it drops over the high rock wall of the main stream, where an excellent dump for tailings is thus provided. Water was brought

from Timberline Creek, a distance of 1½ miles, by a ditch and a short line of pipe for the purpose of moving gravel on the bench at the mouth of the little stream, and mining operations were carried on in 1909 but were not continued in 1910. The gravel resembles that of the creek except that it is cleaner and contains more sand. The same trouble from bowlders was experienced here as on all other parts of Valdez Creek.

Lucky Gulch is a small gulch tributary to Roosevelt Creek near the junction of Roosevelt and Valdez creeks and is about 6 miles from the main camp on Valdez Creek. It is a steep, narrow gulch, little more than a mile long, and draws most of its water from melting snow. Since the gulch is on the north slope of the mountain, the snow that drifts in and fills it in winter melts slowly in summer, thus both preventing work in the early part of the open season and providing the only source of water for mining later in the summer. The slate bedrock of Lucky Gulch dips about 20° N., so that the dip of the slate and the fall of the creek are about the same in many paces. On account of the narrowness and steepness of the channel there is no opportunity for the accumulation of any considerable body of gravel, and such as does accumulate consists of angular fragments and slabs of slate. Well-washed and rounded gravel is present only in small amount.

The gold from Lucky Gulch is coarser than that from any other part of the Valdez Creek district. In general it is rough, with spines and protuberances, yet some of the large pieces are flattened and smooth. Large nuggets form a very considerable part of the product of the creek. One was found in 1910 that weighed 32 ounces. The largest ever found weighed 52 ounces. Many of the nuggets contain sugary quartz, and it is evident that the gold is of local origin and has traveled only a short distance.

A short season and small supply of water counterbalance in large measure the advantage due to the freedom from granite bowlders that Lucky Gulch enjoys over Valdez Creek. Large slabs of slate are common in the gulch, but most of these can be broken with a sledge, or, if this fails, with a small charge of powder, and thus removed. The gravel deposits are worked by booming or sometimes with a small nozzle and hydraulic hose. Part of the gulch has been worked out, but there still remains a large amount of ground to be exploited.

Rusty Creek is 4½ miles east of the Valdez Creek camp and is the principal tributary of White Creek. The valleys of these two streams, White and Rusty creeks, are the largest that have been cut into the mineralized slate mass south of Valdez Creek. They head in the complex of slates, tuffs, and basalts of the ridge north of Windy Creek, and run north through the slates to Valdez Creek. Both of these streams offer promising ground to the prospector. Such pros-

pecting as has been done on White Creek has not resulted in any definite results and was carried on under much difficulty and expense, due in part to the high cost of supplies and lumber but principally to troubles that arose from depth of gravel and much water. Such results as were obtained did not appear to the miners to warrant the heavy expense required for thorough prospecting at that time.

Prospecting on Rusty Creek has been conducted for three years in the face of many difficulties and much expense without any returns, and it was not till the end of the 1910 season that results of much promise were obtained. During the three years preceding, a large cut several hundred feet long and over 25 feet deep in places was made in the creek channel just at the place where the White and Rusty Creek valleys join Valdez Creek valley. This was accomplished by booming—that is, by the use of a dam with an automatic gate which opens periodically and releases a large volume of water. The water rushes through the cut, tearing up the gravel and washing it away. By this method a deep, narrow cut, begun in the expectation of reaching bedrock at no considerable depth, was made in the gravel deposits. The cut follows the east wall of an old gulch or canyon and exposes the northward-dipping slates on that side, but the bottom of the canyon was not reached at the end of the working season of 1910.

The gravels filling the old gulch include an upper deposit of unsorted glacial débris from 10 to 20 feet thick, made up of slate and basalt. Below this is another deposit of fairly well sorted gravel and coarse sand with a distinct cross-bedding. There are many large bowlders in the cut, derived chiefly from the upper glacial deposit. Most of them are basaltic in character and come from the head of Rusty Creek. There are also a few granite bowlders.

Encouraging gold prospects have been secured from the projections or benches of the rock wall on the east side of the cut and especially from the bottom of the cut, where work ended in 1910. The gold is very rough and bright. Few pieces of greater value than 20 cents were found during any of the mining until the end of last season, but there was a noticeable increase in coarseness in the last gold taken out that lends encouragement to the belief that the bottom of the cut is now near bedrock.

Rusty Creek and White Creek give greater promise for extension of the gold-producing ground of the district than any of the other streams, and it is believed that they should be thoroughly prospected. It is impossible to predict whether the concentration of gold in their gravels will be found sufficient to yield rich placer deposits, but the streams cut mineralized slates that are known to be gold bearing and there has undoubtedly been some concentration of gold during the time that erosion of the slates has gone on.

Timberline Creek also is another possible source of placer gold, as it heads in the mineralized slate area. A little prospecting has been carried on, but without particularly encouraging results. The discovery of other gold-producing gravels in the Valdez Creek district is highly desirable, because it is evident that most of the rich channel gravel of the original creek claims is worked out.

CHISTOCHINA GOLD FIELD.

All the gold-producing ground of the Chistochina district lies between the west and middle forks of Chistochina River. It includes Slate Creek and Miller Gulch, Chisna River, its tributary Ruby Creek, and the tributary of the Middle Fork called Lake Creek on the older maps but now known to the miners as Lime Creek. To complete the list of localities where mining operations are conducted in this district, there should be added that on the west side of Chistochina River, near the mouth of Chisna River, where the post office, Dempsey, is situated.

The geology of this small area was described by Mendenhall[1] and may be stated briefly as follows: South of the depression formed by the valleys of Slate Creek and the upper part of Chisna River is a series of tuffs, quartzites, and conglomerates with associated igneous rock, called the Chisna formation. This formation is conspicuous because of its red color, due to the oxidation of pyrite in the rocks that form it. North of the depression is the Mankomen formation, which in this vicinity is made up of limestone and shale, locally metamorphosed to slate. These two formations are separated by a fault of unknown displacement by which the Chisna formation is raised relatively to the Mankomen. The Mankomen formation is of late Carboniferous age. The Chisna formation is older, but probably Carboniferous also. Patches of coal-bearing Tertiary shale have been exposed in the channel of Slate Creek by mining operations.

During the last 11 years, since the discovery of gold in 1899, most of the rich creek gravels of Slate Creek and Miller Gulch have been worked out, yet there still remain creek claims of lower grade and bench gravels that have not been touched. The total production of Slate Creek and Miller Gulch is about $1,500,000.

There are about 20 creek claims on the channel of Slate Creek and 7 on Miller Gulch. Between 40 and 50 men were employed in the Chistochina district in 1910, most of whom were on Slate Creek. They were scattered along at several camps, from "No. 3 below" to the lower end of the creek.

[1] Mendenhall, W. C., Geology of the central Copper River district: Prof. Paper U. S. Geol. Survey No. 41, 1905, pp. 24 et seq.

The first three claims above the mouth of Slate Creek are virgin ground but are difficult to work because of the depth of the gravel and the large amount of water. A hole 21 feet deep near the south side of the gravel bar did not reach bedrock. Tailings from the claims above are another source of trouble. A dam was built on the lowest claim in 1910 to furnish water for booming a low bench on the north side of the creek. This was not completed in July, 1910, when the creek was visited.

On the fourth, eighth, and ninth claims above the mouth of Slate Creek mining was confined to the bank on the south side of the stream. A heavy deposit of glacial material, consisting of blue clay or glacier mud and large bowlders, is exposed on that side. It is overlain by a deposit of frozen yellow talus material or shale rock from the mountain side on the south, ranging from 5 to 25 feet in thickness. The glacial material contains gold and is exploited by undermining and caving. Bowlders are piled back from the cut to form a channel along the foot of the bank and then the water is turned in to cut the bank, and wash away the fine gravel. Afterward the remaining gravel and gold is shoveled into the sluice boxes. This work is slow and very dangerous, because the high bank of frozen gravel above sloughs off continually as it thaws and at times breaks down in large masses, so that men must be constantly on the alert and ready to jump to a place of safety.

The largest force of men on the creek was at work near the mouth of Miller Gulch on ground that has been the richest of the district and is still producing gold. This Tacoma claim, as it is called, together with the lower part of Miller Gulch, has yielded much more gold than all the other claims together. The gravels of Slate Creek above Miller Gulch are of lower grade than those below, and fewer men have been employed there, yet their contribution to the gold production of the creek is important.

There was less mining on Miller Gulch in 1910 than in previous years. This was not due to the exhaustion of gold-bearing gravels. Work was partly suspended in order to avoid covering unworked gravels in Slate Creek with tailings and will be resumed another year. The water supply of Miller Gulch available for mining operations is small, so that it has been the custom of the two principal claim owners to use it in alternate years. In this way all the bed of the gulch has been worked out, but there still remain bench gravels that will be exploited as soon as the ground below can be used for dumping.

The most important gold-producing creek in this district, after Slate Creek and Miller Gulch, is Ruby Creek, which lies just east of Slate Creek across a low, flat divide. Ruby Creek has thrown out a broad fan of gravel extending outward in a semicircle from the point

where the creek leaves the narrow gulch in the mountains at the head of Chisna River, thus forming a smooth slope to the west, south, and east. The creek has cut a channel ranging from 15 to 20 feet in depth in this gravel fan. The gravels are gold bearing and mining is carried on in them, and also in a short bend of filled and abandoned channel at the head of the fan just within the gulch. From some cause the creek cut a new rock-walled channel within a few feet of its former channel at the point where it leaves the mountain. The gold content of the gravels that filled the old channel is low but still great enough to encourage prospecting and pay the bare expense of doing it. Work is greatly hindered by snow and ice, which in some summers do not melt, so that even the water for sluicing is brought through a tunnel in the ice. Bedrock has not been exposed in the channel of Ruby Creek where it crosses the gravel fan. The false bedrock which holds the gold is a gravelly clay bed but a few inches in thickness. Ruby Creek, in cutting its present channel, has concentrated the gold contained in the gravel removed and has left it on these clay beds. Only a few feet of gravel is shoveled into the sluice boxes and care is used not to go below the false bedrock into the barren gravel beneath.

Mining operations on Lime Creek at the head of the middle fork of Chistochina River are on a bench well above the creek and about 1½ or 2 miles east of the divide between the heads of Lime Creek and Chisna River. The section exposed in mining shows about 6 feet of heavy bowlder wash resting on blue glacier clay containing small angular fragments, which is overlain in turn by more of the heavy bowlder wash, the whole section having a thickness of 30 to 40 feet. A large amount of greenstone is present in the deposit and is associated with slate, limestone, conglomerate, and granite. The richest deposit of gold is found in a rusty gravel seam on the blue-clay bedrock. Copper nuggets ranging in size from shot to pieces of several pounds are caught in the sluice boxes. They resemble those of Chititu and Dan creeks, in the Nizina district, and like them are probably derived from copper deposits in basalts or greenstones. Greenstone that resembles the Nikolai greenstone[1] is exposed in the mountain northwest of Lime Creek.

Work on Chisna River was in the nature of assessment work and prospecting. Considerable ground is held there by different persons awaiting the time when the introduction of hydraulic machinery or other economical mining methods shall make mining more profitable. At present the cost of labor and supplies prevents development of much of the gold-bearing gravels. Wages are $10 a day without board, and freight costs from 20 to 25 cents a pound

[1] Schrader, F. C., and Spencer, A. C., The geology and mineral resources of a portion of the Copper River district, Alaska, a special publication of the U. S. Geol. Survey, 1901, p. 40. Moffit, F. H., and Maddren, A. G., Mineral resources of the Kotsina-Chitina region, Alaska: Bull. U. S. Geol. Survey No. 374, 1909, p. 23.

Work at Dempsey is also in the nature of prospecting. Considerable time has been expended in driving a tunnel into the bench gravels west of Chistochina River in the belief that an old channel would be discovered. The gravels yield some fine gold.

Mendenhall regarded the slates of the Mankomen formation as the source from which the placer gold was derived. This conclusion appears justified by the distribution of gold in the gravels, the character of the gold itself, and a study of the geology of the region. It seems evident, for instance, that the richness of Miller Gulch was due to local mineralization of the slates and concentration of gold in the gravels formed during erosion and weathering of the rocks containing it. Failure to find important lode deposits can not be considered as evidence against this source of the gold any more than the failure to find large nuggets in a gravel deposit is evidence that no gold is present. The presence of bowlders of granite, hornblende porphyry, and other rocks from the main range north of Slate Creek is one of the results of former glacial activity but is not in itself proof that the gold of Slate Creek was introduced in the same way.

If the principal source of gold in this district is in the Mankomen formation and the gold of Chisna River is derived from that source, as is indicated by the fact that so far as the writer knows these streams cutting the Chisna formation are not gold bearing except where they have received some contribution of foreign gravels from the north, it is probable that rich pay streaks with coarse gold should not be expected on the lower Chisna and Chistochina. The hope of prospectors there should be for the discovery of large supplies of low-grade gravels that may be exploited in an extensive way by economical means. This statement is believed to be valid unless it shall be shown that there is some other source of the gold than that referred to previously.

PRELIMINARY REPORT ON A DETAILED SURVEY OF PART OF THE MATANUSKA COAL FIELDS.

By G. C. MARTIN.

INTRODUCTION.

The purpose of this paper is to present briefly the more important practical results of a detailed geologic investigation of the area covered by the Chickaloon special map. This area includes the commercially more important part of the Matanuska coal fields, which is situated in the south-central part of Alaska about 30 miles northeast of the head of Cook Inlet.

The larger geographic and geologic features of the Matanuska Valley are described and all the information then available concerning the coal is given in earlier publications,[1] to which the reader is referred. The contents of this paper are but the summary of and the provisional conclusions from the results of the detailed investigations of 1910, which will subsequently be published in full.

GEOLOGIC OUTLINE.

GENERAL FEATURES.

Among the more important geologic results of this investigation is the acquisition of a considerable amount of new information concerning the local stratigraphic sequence. These facts will be presented in detail in the final report. The following table gives a summary of the geologic succession of the rocks in accordance with the new information:

[1] Martin, G. C., A reconnaissance of the Matanuska coal field, Alaska, in 1905: Bull. U. S. Geol. Survey No. 249, 1906, 36 pp. Paige, Sidney, and Knopf, Adolph, Geologic reconnaissance in the Matanuska and Talkeetna basins, Alaska: Bull. U. S. Geol. Survey No. 327, 1907, 71 pp.

General sequence of rocks in area covered by Chickaloon special map.

Age.	Character of rocks.	Thickness.
Quaternary.	Alluvium, terrace gravels, and moraine.	*Feet.* 0–300+
Pliocene (?).	Lavas, capping Castle Mountain.	800
	Intrusive rocks, mostly basic.	
Miocene (?).	Conglomerate, on Castle Mountain and Wishbone Hill.	3,000
Eocene.	Shale and sandstone, with coal beds.	2,000±
	Arkose, conglomerate, and shale, without known coal.	2,000±
Upper Cretaceous.	Sandstone and shale.	4,500±
Lower Cretaceous (?).	Limestone.	200±
Lower Jurassic.	Volcanic breccias, agglomerates, and tuffs.	1,000±
Early Mesozoic or older.	Granitic rocks.	
Paleozoic.	Gneissic rocks.	

CRYSTALLINE ROCKS BENEATH THE COAL.

The rocks grouped under this heading in this discussion and on the geologic map (Pl. VIII) include the gneissic and granitic rocks, the Lower Jurassic volcanic breccias, agglomerates, and tuffs, and the possibly Lower Cretaceous limestone represented in the general section above. These rocks are grouped together because of the facts that they are all known to be far beneath the coal and that none of them are individually of importance in a discussion of the coal.

Large bodies of gneissic and granitic rocks, which are intimately associated with one another and which have not been separated, occur in the Talkeetna Mountains and are present along most of the northern border of the area represented on the map.

Lower Jurassic volcanic breccias, agglomerates, and tuffs occupy an area east of Kings River along the northern edge of the area shown on the map, and are probably present also in the valley of Coal Creek. These rocks are overlain by a presumably Lower Cretaceous limestone which has been seen only along the northern border of the mapped area east of Kings River.

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The rocks grouped under this heading in this discussion and on the geologic map (Pl. VIII) include the gneissic and granitic rocks, the Lower Jurassic volcanic breccias, agglomerates, and tuffs, and the possibly Lower Cretaceous limestone represented in the general section above. These rocks are grouped together because of the facts that they are all known to be far beneath the coal and that none of them are individually of importance in a discussion of the coal.

Large bodies of gneissic and granitic rocks, which are intimately associated with one another and which have not been separated, occur in the Talkeetna Mountains and are present along most of the northern border of the area represented on the map.

Lower Jurassic volcanic breccias, agglomerates, and tuffs occupy an area east of Kings River along the northern edge of the area shown on the map, and are probably present also in the valley of Coal Creek. These rocks are overlain by a presumably Lower Cretaceous limestone which has been seen only along the northern border of the mapped area east of Kings River.

MESOZOIC SEDIMENTARY ROCKS.

The rocks included under this heading comprise the Upper Cretaceous shales and sandstones of the table on page 129. They apparently have a thickness of at least 4,500 feet. These beds lie beneath the coal-bearing rocks, and consequently the area occupied by them is barren of coal. It should be noted that the character and age of these beds were not recognized in the earlier investigations and that they are included in the areas mapped as Tertiary by Martin [1] and by Paige and Knopf.[2]

TERTIARY ROCKS.

The Tertiary rocks of the Matanuska Valley have been divided into three sedimentary formations and include also volcanic and intrusive rocks.

ARKOSE, CONGLOMERATE, AND SHALE, WITHOUT KNOWN COAL.

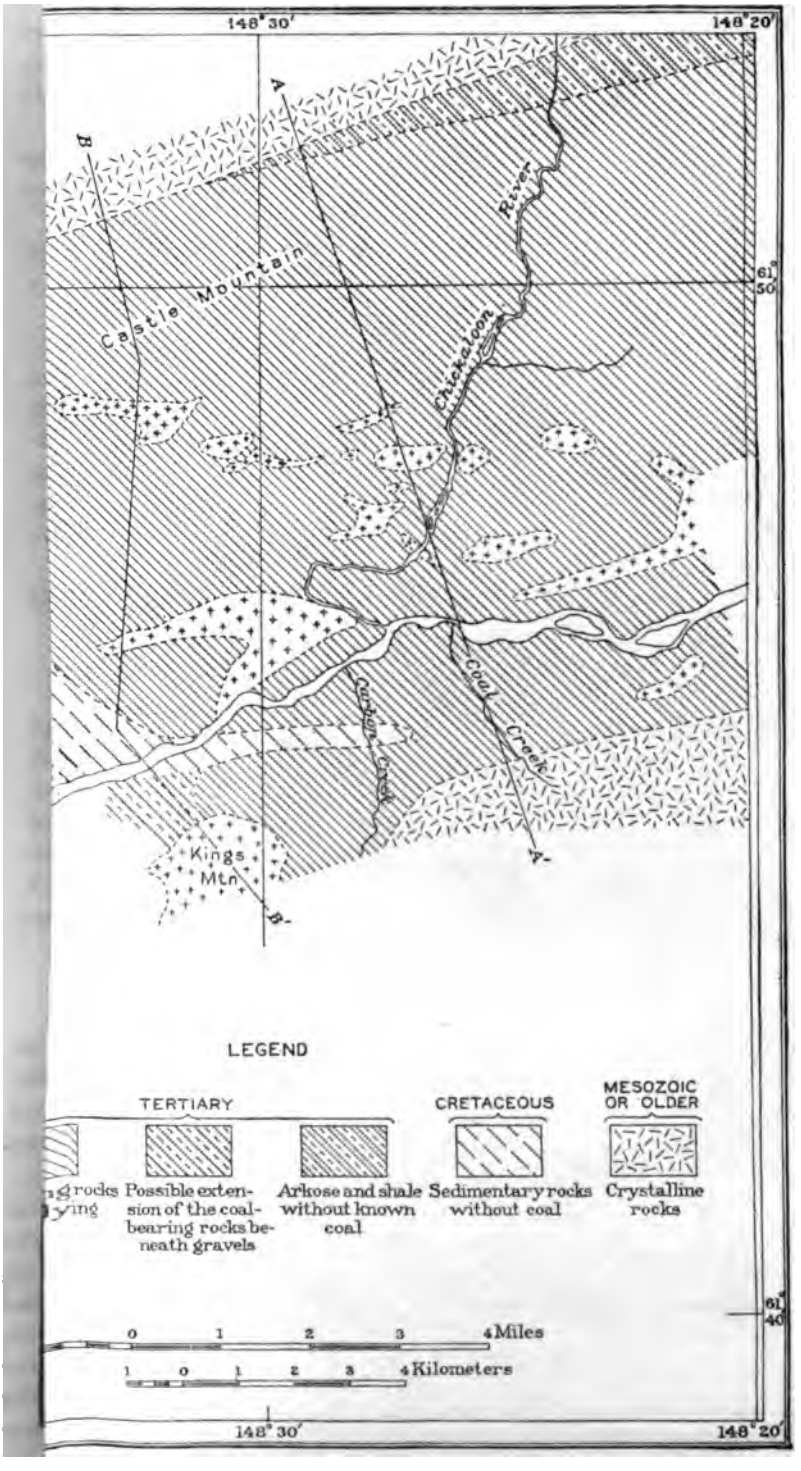
The basal division of the Tertiary consists of beds predominantly arkosic and well indurated, which occupy large areas along the northern border of the Matanuska Valley. These rocks are apparently without coal. They have been separated from the other Tertiary sedimentary beds described below on the basis of their predominantly arkosic character, greater degree of induration, and absence of coal. There is believed to be little doubt that these rocks are for the most part low in the local Tertiary sequence and include the basal beds, although there is a possibility that the assemblage represented on the map includes in part the marginal facies of some beds higher in the Tertiary, as well as higher beds not necessarily marginal but now occurring in structural zones in which they have been deformed to a degree not permitting their separation from the basal or marginal deposits. The thickness of these beds exceeds 2,000 feet.

COAL-BEARING ROCKS.

The coal beds of this district occur in a rather monotonous succession of shales and sandstones. The shales, which predominate over the sandstones in aggregate thickness, are gray to drab, rather soft and inclined to disintegrate on exposure, poorly bedded, and without well-defined joint planes. Most of the beds are rather gritty and vary in grain along the bedding. They contain many nodules and lines of nodules of iron carbonate, some of which form fairly persistent beds. The sandstones are yellowish, rather soft, of diverse grain in the different beds and of varying grain in the same bed, for the

[1] Martin, G. C., Geologic reconnaissance map of the Matanuska Valley: Bull. U. S. Geol. Survey No. 289, 1906, Pl. III.

[2] Paige, Sidney, and Knopf, Adolph, Geologic reconnaissance map of the Matanuska and Talkeetna region: Bull. U. S. Geol. Survey No. 327, 1907, Pl. II.


148°30'
148°20'
A
B
Castle Mountain
River
Chickaloon
61°50'
Coal Creek
Kings Mtn
A'
B'
LEGEND
TERTIARY
CRETACEOUS
MESOZOIC OR OLDER
Possible extension of the coal-bearing rocks beneath gravels
Arkose and shale without known coal
Sedimentary rocks without coal
Crystalline rocks
0 1 2 3 4 Miles
1 0 1 2 3 4 Kilometers
61°40'
148°30'
148°20'

most part feldspathic, and in general the individual beds are not very persistent. The thickness of the coal-bearing rocks is doubtful, but it appears to be at least 2,000 feet.

Fossil leaves are present in both shales and sandstones and are especially abundant and well preserved in the beds carrying iron carbonate.

The coal beds are numerous. There is no evidence as to their exact position within the formation or as to the persistence of individual beds or groups of beds.

The coal-bearing beds are overlain by conglomerates aggregating about 3,000 feet in thickness. These conglomerates are well exposed in the banks of Moose Creek; on Wishbone Hill, which is between Moose and Eska creeks; and on Castle Mountain and in the hills east of it. Since the coal-bearing rocks underlie the conglomerate, the areas of the conglomerate are included in the coal area as represented on Plate VIII and in the table on page 134, although there is no positive evidence as to whether workable coal is present in these areas.

The conglomerate is overlain unconformably on Castle Mountain by about 800 feet of volcanic rocks.

INTRUSIVE ROCKS.

Several large and many small masses of igneous rock have been intruded into the Tertiary beds in the valleys of Chickaloon and Kings rivers and elsewhere in the eastern part of this region. These intrusives are known in the valleys of Eska and Moose creeks only in the form of very small dikes and sills, except possibly on the northern border of the region. Gabbro, diabase, diorite, and several kinds of porphyritic and fine-grained rocks are known to be represented among these intrusives.

GRAVELS.

The Quaternary deposits of this region are of considerable diversity of character and cover broad areas. They include glacial morainic deposits, gravels laid down by glacial waters, terrace gravels more remotely connected with glacial agencies, and the alluvial deposits on the present flood plains.

The terrace gravels are of wide extent and thoroughly mask the underlying rocks up to an altitude of about 1,000 feet, except where the larger streams have cut gorges through the gravels. These gravels are of extreme importance in a consideration of the coal, because they conceal the underlying rocks over broad areas, thus making it very difficult to estimate the actual areas of coal lands or to determine the details of the stratigraphy and structure. The thickness of these gravels ranges from 300 feet or more down to the vanishing point.

COAL.

STRATIGRAPHIC POSITION AND SECTIONS.

The coal beds of the part of the Matanuska Valley here under discussion are all known to be of Tertiary age and to agree approximately in general stratigraphic position with the coal of the Kenai formation on Cook Inlet. They all occur within the middle local division of the Tertiary rocks as grouped in this report. Their exact position within this division has not been determined, but they seem to be in general distributed throughout the greater part of its thickness. Nothing definite is known concerning the persistence of individual beds or of groups of beds.

Detailed measurements of most of the known coal beds are available in previous publications,[1] to which the reader is referred for such information. The following sections record measurements of exposures which were not seen at the time the earlier work was done and represent practically all of the unpublished information relating to coal sections:

Section of coal bed on east bank of Coal Creek, about 1 mile above Matanuska River.

	Ft.	In.
Gray shale.		
Coal	4	7
Shale		2
Coal		3
Shale		½
Coal		8
Shale		1
Coal		7
Shale		2
Coal	1	7
Shale		1
Coal		11
Carbonaceous shale	2	5
Shale and coal, altered by intrusion		6
Total coal	10	7

Strike N. 67° E.; dip 65° NW.

[1] Martin, G. C., A reconnaissance of the Matanuska coal field, Alaska: Bull. U. S. Geol. Survey No. 289, 1906, pp. 18–25. Paige, Sidney, and Knopf, Adolph, Geologic reconnaissance in the Matanuska and Talkeetna basins, Alaska: Bull. U. S. Geol. Survey No. 327, 1907, pp. 43–56.

Section of coal bed on north face of Red Mountain, elevation 3,600 feet (about 4 miles north of mouth of Young or Little Kings Creek or 3.4 miles west of U. S. L. M. No. 1).

Shale with ironstone nodules.	Ft.	In.
Coal, exposure obscure and thickness estimated	7	5
Shale		1½
Coal [1]	1	2
Shale		1
Coal [1]		6
Shale		1½
Coal [1]		7
Shale		¾
Coal [1]		4
Shale		½
Coal [1]		2
Shale		¾
Coal [1]	2	
Total coal	12	2

Strike N. 67° E.; dip 54° SE.

Another coal bed at least 5 feet and possibly 10 feet thick is poorly exposed about 30 feet stratigraphically above this, the intervening rocks being shale with ironstone nodules and sandstone. About 30 feet higher another bed of unknown thickness is present, and 50 feet still higher the smut of another bed was seen.

The presence of coal at this locality adds a hitherto apparently unknown coal area to the Matanuska fields.

Section of coal bed on east bank of Moose Creek, 4.1 miles north of its mouth.

Carbonaceous shale with ironstone nodules.	Ft.	In.
Carbonaceous shale with seams of bony coal	1	
Coal		7
Bone and shale		1
Coal		10
Bone		2
Coal		9
Shale with coaly streaks	7	
Coal	1	
Shale		1½
Coal		3
Shale		½
Coal	1	5
Bone		1
Coal		10
Nodular shale.		

Strike N. 65° E., dip 80° SE.

[1] Included in sample No. 11382F, p. 138.

COAL AREAS.

EXTENT.

The areal extent of the assemblage of rocks which carry the coal is indicated on the geologic map (Pl. VIII). The map shows also by a separate pattern the areas which may be underlain by these rocks but in which the lack of exposures caused by the presence of gravels on the surface or the indefiniteness of lithologic character of the exposed rocks makes it uncertain whether the coal-bearing rocks are present.

These are the areas which may carry coal as distinguished from the areas which are known not to carry coal, represented by other patterns on the map. The areas of the "coal-bearing rocks" can not be assumed to be underlain wholly by beds of coal of workable character and thickness. Moreover, parts of these areas may have no coal under them. The lack of knowledge as to the exact stratigraphic position of the coal beds, the uncertainty as to what stratigraphic part of the "coal-bearing rocks" is represented by the various surface outcrops, and the concealment of the rocks by gravels over broad areas make the precise areal distribution of the coal a problem which can be solved only by drilling or other underground exploration.

The areas of the tracts which it is believed may possibly contain workable coal are indicated in the following tables. The first of these tables shows the areas known to be occupied by the "coal-bearing rocks," as defined above, and by the conglomerates and other beds which overlie them. The second table shows the areas which may also be underlain by these rocks but in which, because of concealment by gravels or because of other lack of definite information, there is a possibility that other formations may be present. These estimates are provisional and may be revised when the field notes are fully worked up.

Areas of supposed coal-bearing rocks.

	Square miles.
Valleys of Chickaloon and Kings rivers	44
South of Matanuska River, between Kings Mountain and eastern edge of area shown on Chickaloon special map	8
Valley of Young Creek	3
Valleys of Moose and Eska creeks	19
	74

Areas of possible extensions of supposed coal-bearing rocks.

	Square miles.
Lower parts of valleys of Kings and Granite creeks	8
Valleys of Moose and Eska creeks	16
	24

STRUCTURAL CONDITIONS.

It is not practicable in this brief report to present an adequate discussion of the structure of this region. This will necessarily be left

for the detailed report. The general character of the structure is indicated in the sections on Plate IX. The coal-bearing rocks, like most of the other rocks of this region, have been strongly folded so that steep dips and complex structures are present throughout most of the area. In places there is a continued uniform dip for considerable distances, as is shown in section A–A′, Plate IX, but it is not known whether this condition means simple monoclinal structure or a repetition of parallel fault blocks. At other places there are frequent reversals of dip, but these may be due either to simple folding or to more complex faulting. In each of these cases the lack of definite knowledge concerning the type of structure is due to the absence of recognized characteristic strata from the distribution of which the actual structural details could be inferred.

In two areas within the field the type of structure is known with a fair degree of certainty. These areas are the ones occupied by the conglomerate in the vicinity of Castle Mountain and of Wishbone Hill. Here the clearly defined contacts of the conglomerate with the adjacent rocks, as well as the numerous individual beds of conglomerate, make it possible to determine the actual structural details.

The western end of Castle Mountain (see section B–B′, Pl. IX) is a monoclinal block having a dip of about 6° to 20° NE. The eastern end (shown in section A–A′, Pl. IX) is a syncline having a broad southern limb on which the dips range from 10° to 20° N. and a narrow, sharply upturned northern limb with dips of 60° to 90°. Possibly the northern limb of this syncline is cut off in the western part of the mountains by a fault, or on the other hand the structure may be dominantly monoclinal with local upturning of the strata along the fault in the eastern but not in the western part of the mountain.

Wishbone Hill is in general structurally similar to Castle Mountain. The eastern end (shown in section D–D′, Pl. IX) is a syncline pitching sharply toward the west. The western end is likewise synclinal, but the northern limb of the syncline has been cut by a fault in the western end of the hill and in the valley of Moose Creek, as is shown in section E–E′, Plate IX, so that the conglomerate mass as exposed on Moose Creek shows dominant northward dip and but for a few exposures showing gentle southward dip would appear to be a monoclinal block.

The points of dissimilarity between Castle Mountain and Wishbone Hill are that on Castle Mountain the entire northern edge is bounded by a fault which has brought the arkosic rocks beneath the coal into contact with the conglomerate above the coal, whereas on Wishbone Hill the fault is possibly absent at the east end so that the coal-bearing rocks encircle the end of the conglomerate mass, and at the west end the fault is not of sufficient magnitude to bring more than the coal-bearing rocks into contact with the conglomerate. The

syncline at the east end of Castle Mountain pitches toward the east, whereas the one at the east end of Wishbone Hill pitches toward the west.

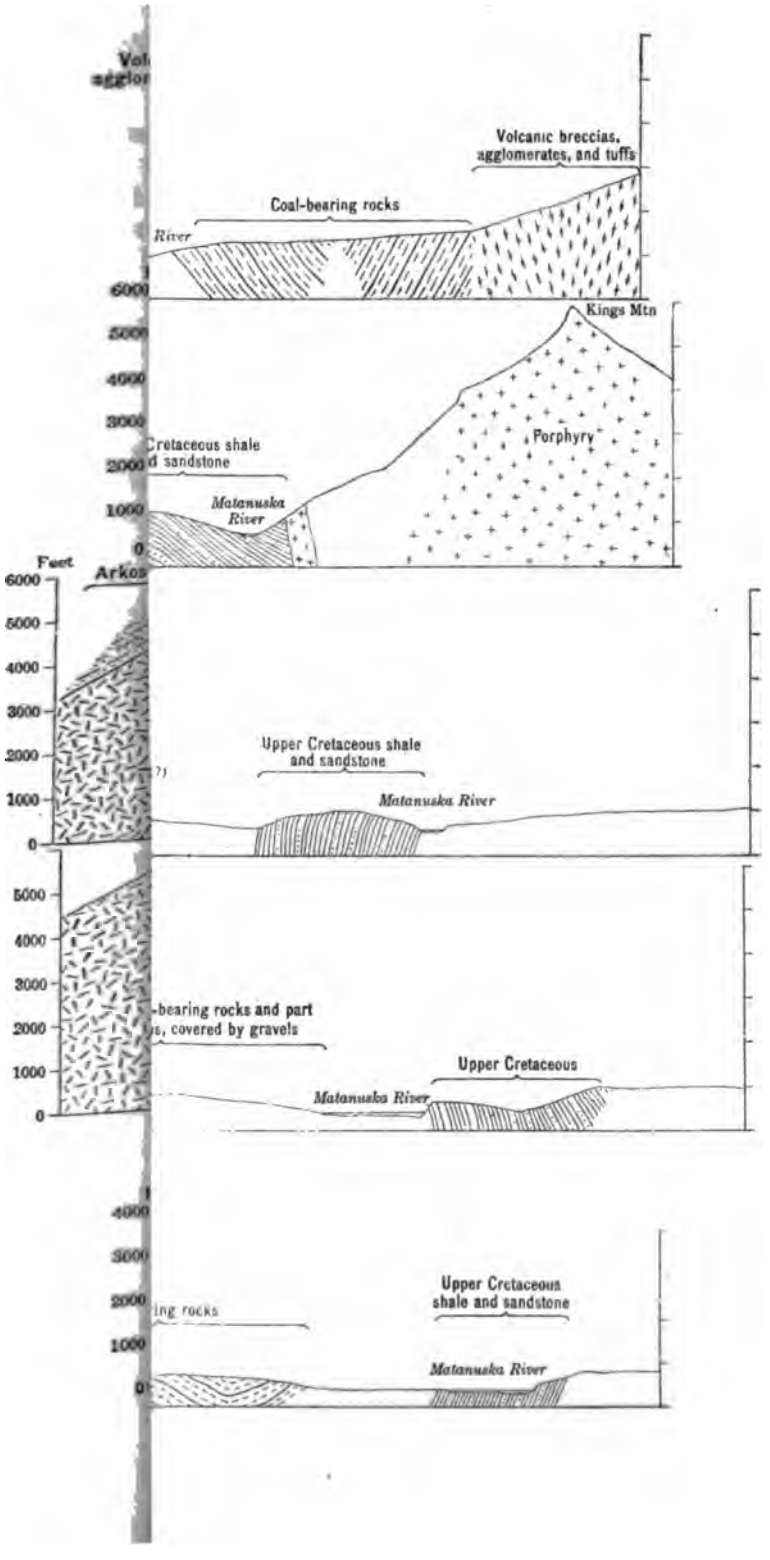
Both Castle Mountain and Wishbone Hill are of fairly simple structure, so that if the coal beds persist beneath the conglomerate, and if the coal-bearing rocks were not folded before the conglomerate was laid down, mining should be simple, at least as far as structural conditions are concerned.

It may perhaps be considered probable that the structures of the entire valley are of the same general type as those known in the areas of the conglomerate. If this is the case, there are probably large areas in which structural conditions will permit the mining of the coal. This condition can not, however, be definitely assumed to exist, and the character of the structure must be regarded as a problem to be solved by underground exploration before the feasibility of mining at a profit the coal of any particular tract can be demonstrated.

EFFECT OF INTRUSIVE ROCKS.

Intrusive rocks are present in abundance and in large masses throughout the greater part of the area of coal-bearing rocks except in the valleys of Moose and Eska creeks, where they are small and are much less numerous than farther east. The areal distribution of the larger of these intrusive masses is indicated on the map (Pl. VIII). Small dikes and sills, not represented on the map, are also present throughout practically all the coal areas. Where the intrusives cut the coal beds the coal is rendered worthless for a distance of a few inches from the contact. The small dikes and sills, on account of the short distance to which their effect extends, would not affect the coal seriously, except that the sills show a habit of seeking coal beds for their planes of intrusion. It is clear that if a sill is intruded into a coal bed for a long distance a large amount of worthless coal will result, whereas if it is intruded between rock strata, even if only a few feet away from the coal bed, or if it cuts across the coal bed in the form of a dike, its effect on the coal will be slight.

The larger intrusive masses are of much more serious importance than the small dikes and sills, first, because their size is sufficient to reduce the coal areas very considerably, and, second, because each of them is likely to have sent off many apophyses in the form of sills in or along the surfaces of coal beds. The dimensions of these masses are, moreover, probably greater beneath the surface of the ground than at the surface. There may also be many intrusive masses which do not outcrop but which are near enough to the surface to be encountered in mining.


Volcanic breccias, agglomerates, and tuffs
Coal-bearing rocks
River
Kings Mtn
Porphyry
Matanuska River
Feet
Upper Cretaceous shale and sandstone
Matanuska River
Upper Cretaceous
Matanuska River
Upper Cretaceous shale and sandstone
Matanuska River

In conclusion, it must be stated that the presence of intrusive rocks in the coal field introduces factors which make an undetermined percentage of the coal areas of very doubtful value. The actual size and distribution of these intrusive masses beneath the surface, as well as at the surface in the areas of scanty outcrops, can not be determined without underground exploration. The effect of the smaller intrusive masses on the coal depends on the extent to which these have been intruded into or on the surfaces of coal beds. Where the intrusive mass is in actual contact with the coal the coal is worthless, but where it is a few feet away the quality of the coal is probably unimpaired or even may be possibly improved.

CHARACTER OF THE COAL.

The physical and chemical properties of the coal have been fully discussed in previous publications. This discussion will not be repeated in detail here. It is sufficient to state that the coal on Chickaloon and Kings rivers and on Coal Creek is high-grade bituminous and is probably at least in part coking coal, whereas that in the western end of the district, namely, on Moose, Eska, and Young creeks, is low-grade bituminous and is probably all noncoking coal. The anthracite described in earlier publications [1] is not known within the area here described but lies farther east.

The following table includes characteristic analyses from different parts of the area. The analysis of sample No. 11382F was taken during the investigations here described. The other analyses have been published in Bulletins 289 and 327 and represent samples collected in 1905. All the samples except Nos. 2215 and 2227 are from surface prospects or from outcrops and are consequently somewhat weathered. Samples 2215 and 2227 are from a tunnel at a distance of 43 to 58 feet from the mouth and probably under about 25 or 30 feet of cover.

[1] Martin, G. C., A reconnaissance of the Matanuska coal field, Alaska: Bull. U. S. Geol. Survey No. 289, 1906, pp. 18–19, 26–30. Paige, Sidney, and Knopf, Adolph, Geologic reconnaissance in the Matanuska and Talkeetna basins, Alaska: Bull. U. S. Geol. Survey No. 327, 1907, pp. 52–56, 59–62.

Analyses and tests of Matanuska coal (samples as received).

Locality.	Laboratory No.	Thickness in feet.	Loss on air drying.	Proximate.				Ultimate.					Heating value.	
				Moisture.	Volatile combustible.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
Chickaloon River, tunnel No. 2[a]	2215	12.3	1.60	2.55	16.66	69.72	11.07	0.57	4.19	76.58	1.37	6.22	7,545	13,581
Chickaloon River, tunnel No. 2, selected sample[b]	2227	5.2	(c)	.99	19.03	75.19	4.79	.60	4.71	83.90	1.48	4.52	8,205	14,769
Coal Creek[d]	2217	5.0	.80	1.97	18.58	75.19	4.26	.50	4.80	82.79	1.79	5.88	8,146	14,663
Kings River[e]	2218	9.9	1.80	2.68	20.69	64.72	11.91	.59	4.68	74.38	.87	5.77	7,422	13,360
Red Mountain[f]	11382F	12.2	6.10	10.57	33.80	50.57	5.06	.23	5.41	65.16	1.13	23.01	6,236	11,225
Eska Creek[g]	2226	2.6	(c)	4.74	34.79	54.06	6.41	.42	5.54	71.06	1.60	14.97	6,985	12,573
Eska Creek[h]	2224	3.3	(c)	5.00	33.90	50.65	10.45	.41	4.77	63.59	1.38	19.40	6,338	11,408
Moose Creek[i]	2225	6.0	(c)	4.75	32.64	50.63	11.98	.38	4.76	64.09	1.09	17.70	6,428	11,570
Moose Creek[j]	2221	11.7	4.60	9.49	33.63	51.71	5.17	.25	5.52	65.85	1.20	22.01	6,445	11,601

[a] Bull. U. S. Geol. Survey No. 289, p. 21, sample No. 2.
[b] Idem, p. 21, sample No. 3.
[c] Not determined.
[d] Idem, p. 20, sample No. 9.
[e] Idem, p. 23, sample No. 13.
[f] This bulletin, p. 133.
[g] Bull. U. S. Geol. Survey No. 289, p. 23, sample No. 18.
[h] Idem, p. 24, sample No. 19.
[i] Idem, p. 25, sample No. 20.
[j] Idem, p. 25, sample No. 21.

A RECONNAISSANCE OF THE WILLOW CREEK GOLD REGION.

By FRANK J. KATZ.

INTRODUCTION.

Placer prospects were found in the Willow Creek region in 1898. Up to 1906 efforts seem to have been directed mainly to the development of the placers of Grubstake Gulch and Willow Creek. So far as the writer has been able to find out the first quartz-lode location was made in 1906 on the ridge between Willow Creek and Fishhook Creek. This was followed in 1907 by other locations on Fishhook and Willow creeks. In 1908 the field was extended on the west by locations on Craigie Creek, and in 1909 by locations to the north and east of Fishhook Creek, around the head basins of Archangel Creek, and on the mountain between that creek and Little Susitna River. Altogether some 60 claims are being developed and several other prospects have been located.

In September, 1906, Paige and Sargent, of the Geological Survey, visited Willow Creek in the course of a general reconnaissance of the Talkeetna region. Paige's descriptions of the geology and placer mining were published in 1907.[1] In September, 1910, after finishing the season's work with G. C. Martin in the Matanuska coal field, the writer, accompanied by Theodore Chapin, spent four days in the Willow Creek region. The observations made and the information collected by them are embodied in this report.

GEOGRAPHY.

Location and area.—The Willow Creek gold field is included in an area 10 miles square which lies in about longitude 149° 20′ west and latitude 61° 50′ north. It is approximately 20 miles northeast of Knik, a settlement on Knik Arm of Cook Inlet. The field occupies the southwestern part of the Talkeetna Range.

[1] Paige, Sidney, and Knopf, Adolph, Reconnaissance in the Matanuska and Talkeetna basins, with notes on the placers of the adjacent region: Bull. U. S. Geol. Survey No. 314, 1907, pp. 104–125; Geologic reconnaissance in the Matanuska and Talkeetna basins, Alaska: Bull. U. S. Geol. Survey No. 327, 1907.

Topography and drainage.—The region comprises the divide between Little Susitna River and the south fork of Willow Creek and is divisible into a northern and a southern part. The northern part is a high, rough mountain mass, whose 6,000-foot summit is sometimes locally spoken of as "the Pinnacle," from which radiate the headwaters of Willow Creek and the western tributaries of Little Susitna River. The southern portion is a somewhat lower and less rugged ridge, called Bald Mountain, lying between the lower courses of Willow Creek and Little Susitna River.

From the central northern mountain Purches Creek, Craigie Creek, and the creek known as the "head of Willow Creek" flow west, southwest, and south-southwest, respectively, to Willow Creek. Fair Angel Creek and Fishhook Creek head against the same mountain and flow southeast and south, respectively, to Little Susitna River. Little Susitna River flows south along the eastern part of the region to the Matanuska Valley and turns west, following the base of Bald Mountain and receiving from it many small tributaries.

The important streams of the northern part of the district are Archangel Creek, with its branches, and Fishhook Creek, which are tributary to Little Susitna River, and Craigie Creek, the "head of Willow Creek," Grubstake Gulch, and Wet Gulch, tributary to Willow Creek. Archangel Creek is a westerly tributary of Little Susitna River. About 1½ miles above the river it forks. The northern branch is known as Reed Creek and the eastern as Fair Angel Creek. Fair Angel Creek heads in several cirques on the east and northeast side of "the Pinnacle." It is about 2½ miles long and has a southeasterly course. Its basin is U-shaped and from 2,400 feet to 3,400 feet in altitude. Fishhook Creek is south and west of Fair Angel Creek. It flows south about 3 miles from a large compound cirque on the south of "the Pinnacle" and then bends sharply east to Little Susitna River. It occupies a U-shaped basin from 2,000 feet to 4,000 feet high and hangs about 300 feet above Little Susitna River. The "head of Willow Creek" is west of Fishhook Creek and occupies a glacial trough 3,000 to 4,000 feet high and about 2 miles long. It flows southwest to Willow Creek (south fork) proper, which flows west. Craigie Creek has a U-shaped valley west of the head of Willow Creek. Its basin is from 2,500 to 3,500 feet high and about 5½ miles long, directed toward the southwest. It hangs about 400 feet above Willow Creek.

The ridges between these streams are narrow, high, and rugged, with steep, craggy upper slopes. Between the head cirques are very sharp arêtes.

In the southern part of the district the important streams besides Willow Creek and Little Susitna River are those in Grubstake Gulch and Wet Gulch, tributaries of Willow Creek. These gulches are gla-

ciated basins about 3 miles long, heading against the north side of the summit of Bald Mountain. There are four minor streams on the north side and a dozen or more small gulches on the south side of this ridge.

Climate.—There are no recorded observations on the climate of Willow Creek region. It may be said, however, that conditions are in general the same as in the lower Matanuska [1] and Susitna basins, with perhaps a slightly heavier precipitation and shorter summer. In 1910 snow lay on some of the prospects at high altitudes, delaying development work until August.

Water supply.—There is little perennial snow in the district, yet considerable ice persists in the broken rock and talus of the higher mountains. From these sources the streams in the northern part of the region were kept high enough during the dry 1910 season to run such small mills as have been erected. Craigie, Willow, Fishhook, and Fair Angel creeks appear to have during the summer sufficient volume and fall to run prospecting and small development mills for the claims located on them. Large power development is possible at the canyon of Little Susitna River, which is less than 10 miles from the farthest prospect.

For the hydraulic placer mining on Grubstake Gulch the creek has in ordinary years furnished ample water, in rainy years more than could be handled, but in an exceptionally dry season it has failed.

Timber.—In the Willow Creek basin there are no trees above the mouth of Grubstake Gulch and no good spruce above the mouth of Wet Gulch. On Little Susitna River good spruce is about a mile below the mouth of Fishhook Creek. The lumber supply is plentiful and good in the lower parts of the Willow Creek and Little Susitna River valleys. The heads of the streams at the prospects are devoid of alders and willows. The gold-quartz prospects are 4 to 8 miles from building and mine timbers, and even brush for fuel must be hauled or packed at least half that distance.

The Matanuska coal field, which is 25 to 50 miles by trail from the Willow Creek prospects, has furnished forge coal and is a prospective source of fuel for the region. Lignite is reported nearer by, on lower Willow Creek.

Routes.—There are three routes from Knik to the Willow Creek district. One trail which is used only in the winter goes north from Knik around the western end of Bald Mountain to and up Willow Creek. By this route it is about 30 miles to the mouth of Craigie Creek. The old summer trail to Willow Creek takes a northeasterly direction through Cottonwood to Bald Mountain, crosses Bald Mountain at an altitude of 3,400 feet, and goes down Wet Gulch to Willow

[1] Martin, G. C., Reconnaissance of the Matanuska coal field, Alaska, in 1905: Bull. U. S. Geol. Survey No. 289, 1906, pp. 7-8.

Creek. This route is about 26 miles. The third route is a fair wagon road which can be used throughout the year. It leaves the winter trail near Knik and strikes northeasterly across the lowlands to Little Susitna River. It crosses to the west bank and follows up the river to the mouth of Fishhook Creek. The distance is 28 miles. The usual route traveled from Knik to Fishhook Creek in summer follows the old Willow Creek summer trail to the wagon road and then the wagon road. There are trails from Willow Creek at Wet Gulch to and up Craigie Creek, to Grubstake Gulch, and up to the head of Willow Creek. From the head of Willow Creek a trail crosses the divide between Willow and Fishhook creeks through a saddle somewhat lower than 4,000 feet. From the mouth of Fishhook Creek trails lead up Fishhook and to the head of Fair Angel Creek.

GEOLOGY.

The distribution of the rocks, which is shown on the accompanying sketch map (fig. 18), may be summarized as follows:

A line drawn west from the pass between Willow and Fishhook creeks and along the north side of Willow Creek marks the contact of a large area of quartz diorite on the north and mica schists on the south. North of Willow Creek the country rock, which is locally called granite, is light colored, of granitic texture, and composed of feldspar (chiefly plagioclase), quartz, hornblende, and biotite. It is uniform in composition and texture. Quartz diorite is scientifically a more accurate name for the rock than granite. There are a very few basaltic (diabase?) and aplitic dikes of small size cutting the quartz diorite. South of the quartz diorite as far as the summit of Bald Mountain and west of Little Susitna River the rocks are thoroughly foliated mica schists. The schistosity has a prevailingly southward dip. Quartz stringers are commonly seen in these schists. On the south flanks of Bald Mountain and the mountain opposite it east of Little Susitna River are Tertiary arkoses, sandstones, and shales. Along the northern limit of the Tertiary area some of the arkoses, which are sedimentary rocks composed of disintegrated granitic material, so closely resemble the granite or diorite adjacent to them that their differentiation in the field requires considerable care. A narrow tongue of granitic rocks appears to lie along the top of Bald Mountain between the Tertiary sediments and the schists. The Tertiary sediments lie unconformably with southerly dip on the quartz diorite east of Little Susitna River and are probably in like relationship on Bald Mountain. The quartz diorite appears to be intrusive into and largely to surround the schists. A small amount of basalt was noticed on the summit of Bald Mountain west of the head of Wet Gulch.

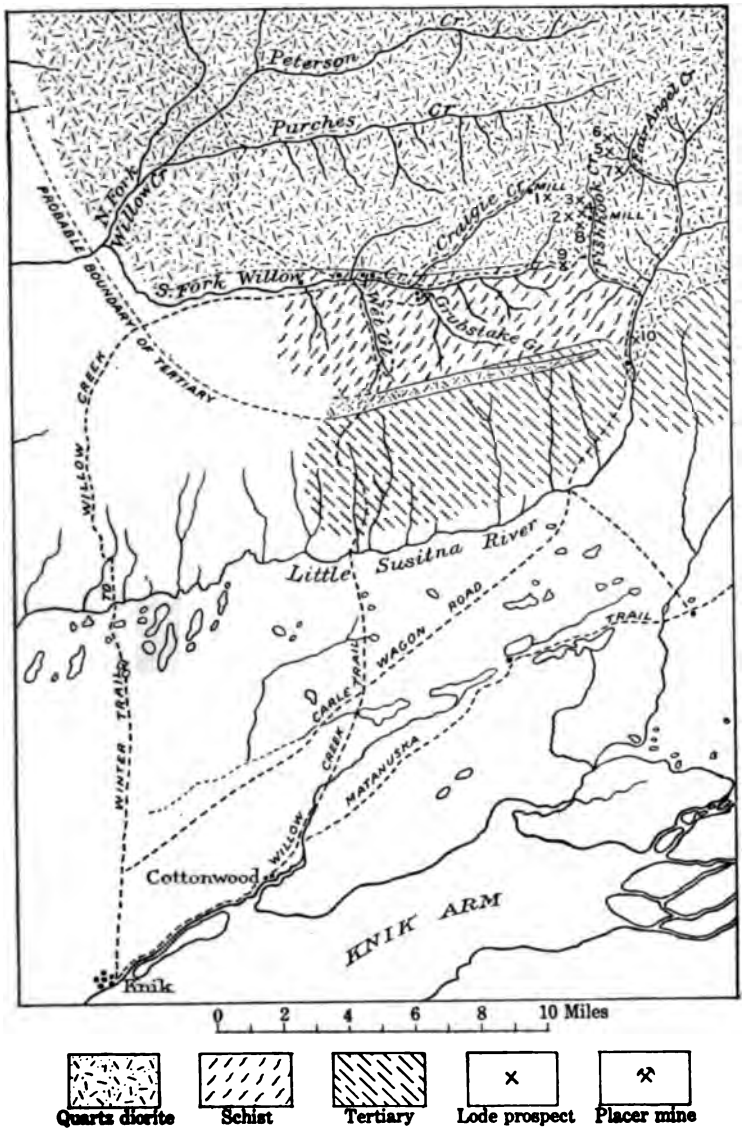


FIGURE 18.—Geologic sketch map of Willow Creek region.

1. **Gold Bullion Mining Co.**
2. **Brooklyn Development Co.**
3. **Gold Quarts Mining Co.**
4. **Free Gold Mining Co.**
5. **Matanuska Gold Mining Co.**
6. Conroy & Marrion group.
7. Fiske & Reed group.
8. Bartholf-Isaacs group.
9. Lydell prospect.
10. Miller prospect.

Recent glacial and stream deposits are present in all the valleys. **Terraced gravel benches** line the lower portions of Willow Creek and **Little Susitna River.**

MINERAL RESOURCES AND MINING DEVELOPMENT.

INTRODUCTION.

The mineral resources of the Willow Creek region are gold placers and gold-bearing quartz lodes. In 1906 Sidney Paige, of the United States Geological Survey, spent two days on Willow Creek and in its vicinity. Descriptions of the gold placers as then developed have been published in the reports by Paige and Knopf.[1] The gold lodes of the region had not been examined by the Geological Survey prior to the visit upon which the present report is based. Such information as could be gathered from reliable reports of prospectors and others interested in the region was summarized and published by Brooks.[2]

GOLD LODES.

GENERAL DESCRIPTION.

As the writer's time in the Willow Creek region was limited to four days, only the more developed prospects were visited. The following account is therefore incomplete.

The important prospects all lie north of Willow Creek in the area occupied by quartz diorite. In this area there are a few small dikes of diabase and aplite. At one prospect only are dikes (aplite) intimately associated with the ore body. The quartz diorite throughout the region is very much jointed. The most prominent and also the dominant systems of joints, which strike N. 40° W. (dip 20° to 40° SW.) and N. 30° E. and N. 60° W. (nearly vertical),[3] cut the rock into huge rhombohedral blocks that form a striking feature in the topography. At higher altitudes the rock does not decompose and disintegrate. Denudation appears to be largely accomplished by the dislodging of joint blocks. The quartz diorite mountains everywhere in the Willow Creek region and as far back as one can see into the Talkeetna Range are consequently marked by peculiar blocky or tilted steplike forms. Single fissure planes are visibly traceable for long distances. Movements along these planes are here and there indicated by slight crushing and slickensiding and do not appear to be important except in so far as they opened the fissures.

The ore bodies of the region, with the exception to be noted below, are quartz fillings in fissures having as a rule sharply defined walls, there being commonly from a small fraction of an inch to 2 or 3 inches

[1] Paige, Sidney, and Knopf, Adolph, Reconnaissance in the Matanuska and Talkeetna basins, with notes on the placers of the adjacent region: Bull. U. S. Geol. Survey No. 314, 1907, pp. 116–118; Geologic reconnaissance in the Matanuska and Talkeetna basins, Alaska: Bull. U. S. Geol. Survey No. 327, pp. 65–67.

[2] Brooks, A. H., The mining industry in 1909: Bull. U. S. Geol. Survey No. 442, 1910, pp. 35–36.

[3] These directions are approximate only and are referred to the magnetic north, declination 28° 38′ E. at Knik, 1906.

of clayey decomposed diorite along the quartz. Many narrow quartz-cemented breccias of the wall rock have been found along or within the veins. The quartz is white and bluish gray, in many places banded and giving evidence of having been broken and recemented along planes roughly parallel to the walls. The veins lie for the most part along fairly regular plane fissures that are persistent, so far as present developments establish absolutely, through several hundred feet, and some are reported to have been traced for several thousand feet. There are also quartz veins or stringers in irregular, less persistent small fissures which are being prospected. These veins are from 1 or 2 inches to 4 feet in thickness. The smallest one which has been located as a "lode," so far as the writer saw them, is 16 inches thick. With few exceptions within the region proper the veins strike nearly northwest with moderate southwest dip.

There is little visible mineralization in most of the quartz. Much pure-white quartz not only assays high but will yield colors on panning. Considerable quartz with abundant visible gold has been found. Here and there on the veins of all the prospects examined minute and sparsely scattered specks of pyrite and other undetermined minerals were found. Tellurides have been reported by several of the operators. However, in none of the material seen by the writer was the supposed telluride mineral sufficient in amount or in grains large enough to be recognized. The surface material is all very slightly porous and rusty. The Geological Survey has made no assay of these ores. The gold content of these veins, as indicated by mill tests and assays reported by the prospectors and owners, is very high. The superintendent of the Gold Bullion Co.'s plant reports $35,375.54 received from 226 tons. Most of this was free-milling gold. High values are reported in concentrates and tailings. Reports of assays of individual samples from other prospects indicate values between $30 and $40 a ton and higher, and all are free milling. All the material thus far examined is from the surface or from points less than 150 feet from the entrance of the adits.

The foregoing discussion applies to the quartz diorite area where quartz lodes are being developed. In the adjoining schist area, particularly on Grubstake Gulch, are gold placers. Concerning the origin of the placer gold, Knopf and Paige in the reports cited state:

> The origin of the gold may be ascribed with certainty to the abundant quartz stringers in the mica schists. The coarseness and roughness of the gold suggest a near source of supply. * * * The fact that placer gold has not been found in paying quantities where streams have headed in granitic or other crystalline rocks bears out this statement.

Recent developments have thrown no light on this problem. It is still true that there are no paying placers in the area of granitic rocks which contains the quartz lodes of the region, but the valleys of

that area are heavily strewn with coarse glacial débris, are farther from timber than Grubstake Gulch and hence are not attractive to the placer miner; furthermore, the prospectors' attention has been concentrated on the lodes. The writer, however, believes that the above quotation ascribes the origin of the placer gold to a source which is not inadequate.

It appears, then, that besides the occurrence of gold in the diorite in veins, large and persistent enough to make workable lodes, gold may also occur in the schist in rather widely distributed small bodies which yield placers.

DESCRIPTION OF THE PROSPECTS.

Craigie Creek.—The Gold Bullion Mining Co. is developing a group of five claims near the summit of the ridge on the south side of Craigie Creek about 5 miles from the mouth of the creek. The lode lies at an altitude of about 4,500 feet, or roughly 1,500 feet above the valley bottom. The mountain slope below the prospect is mantled by glacial débris and talus which contains a great deal of vein quartz in large and small pieces. At and above the prospect there is some talus and the bedrock is considerably disrupted, disturbed, and loosened by weathering (chiefly frost heave). The development work has consisted largely of cleaning out the loosened surface material in order to uncover the lode in firm bedrock. The quartz sorted out in this work has constituted the larger part of the "ore" handled. Through a distance of 3,000 feet several patches of gold-bearing quartz have been encountered. The vein or veins are about 2 feet to 2½ feet thick. Two open cuts and a short adit have been made which show such veins, but all of these were more or less obscured at the time of the visit. A breakdown of the aerial tram had stopped work for about a month and the openings had been permitted to become covered by slide. It seems that the openings are along a single vein or vein zone whose outcrop has an east-west (magnetic) trend and low dip to the south, but this has not been definitely established by the workings.

The ore is quartz in which a little free gold and small specks of sulphides are visible. The quartz is dominantly white but in some places slightly rusty and in others bluish. In some pieces quartz diorite was seen "frozen" to the quartz, but in general both the quartz and the quartz diorite are crushed and seamed parallel to the walls and there is some slickensiding and gouge along the walls.

The Gold Bullion Mining Co. has erected a 2-stamp mill, capacity about 6 tons a day. The mill is run by water power, amply sufficient for five more stamps, which the company intends to install during the winter of 1910–11. A light aerial tram was used to bring the ore down over the high steeper slope of the mountain, below

which the ore was dragged in stone boats for about 100 yards by horses. All wood for building, timbering, and fuel must be either dragged or packed by horses from at least 6 miles below the mill.

Willow Creek.—The Brooklyn Development Co. has 11 claims in and around the basin at the head of Willow Creek. Development work has been confined to one of the claims near the summit of the ridge on the east side of the basin. Here there are three small cuts and an adit 150 feet long. The quartz diorite is much broken up by joints striking from N. 40° W. to N. 65° W. with dips southeast from 23° to nearly vertical. Along the fractures the quartz diorite is much crushed and weathered to clay. Quartz lenses and stringers of small size were seen in the fractured quartz diorite shown in the cuts and in the adit. On the dump at the adit larger chunks of quartz indicated that a vein had been cut (probably near the entrance and now covered by timbering so that it was not seen). This quartz is rusty and shows small scattered specks of pyrite and galena(?). It is reported that the adit was started on a vein with low dip which carried it above the adit. At a number of points along the adit the quartz diorite is fractured, crushed, and much decayed. There are small quartz veins in these fractured parts. The reported values are high.

Fishhook Creek.—The Alaska Gold Quartz Mining Co. operates a group of claims, locally known as the Carle prospect, on the Fishhook Creek side of the ridge between Willow and Fishhook creeks about 3½ miles above the mouth of Fishhook Creek. The prospect is on the steep wall of a small cirque several hundred feet above the level of the main valley floor. The prospect is a quartz vein which has been exposed by stripping the débris along the face of the mountain through 300 or 400 feet. An adit has been driven 150 feet on the vein.

The vein strikes approximately N. 52° W. (magnetic) and dips 24° SW. It is not perfectly plane and its thickness is slightly variable but averages about 2 feet. At 147 feet from the entrance the vein is broken by a dip fault of large hade and 4-foot throw.

The quartz is in part banded, white, gray, and dark bluish, carrying scattered minute sulphides (?), and in part very white, massive, and free from visible mineralization. The walls are sharply defined and generally smooth, with a gouge or clay from a small fraction of an inch to 2 and 3 inches thick. Along the borders of the vein are numerous angular fragments of granite, commonly very much decomposed, included within the vein filling.

All parts of this vein are reliably reported to yield free gold by panning.

Besides stripping between 300 and 400 feet along the outcrop and driving an adit 150 feet on the vein, the company has put up,

on Fishhook Creek, a small water-power 2-stamp prospecting mill without concentrators and has built a trail over the steep mountain face between the prospect and the mill.

Adjoining the Carle prospect on the south and the Brooklyn Development Co.'s property on the east is the Thomas prospect. This is operated by the Free Gold Mining Co. At about the same altitude as the Carle a vein of quartz has been stripped for 500 feet or so along its outcrop. The vein, which strikes N. 40° W. (magnetic) and dips 36° SW., has been entered by a slope adit. This was partly filled with water, so that only the upper part of the opening could be seen by the writer. The vein is about 16 inches thick and in every way similar in appearance to that on the Carle prospect, of which it may be an extension.

Besides the Carle and the Thomas prospects on Fishhook Creek there are several others which were not visited by the Survey party. Quartz from which gold can be obtained by panning has been found all around the Fishhook basin. On the divide between Fishhook and Fair Angel creeks the Reed & Fiske claims have been located. A large number of open cuts on this property indicate a quartz vein continuous for 300 feet, averaging 4 feet wide. The vein in some places includes a granite breccia and has gouge or clay along the walls. The strike is N. 40° W. (magnetic); the dip 30° SW.

Fair Angel Creek.—The Matanuska Gold Mining Co. has begun work on a group of four claims near the head of Fair Angel Creek. The prospect is near the top of a steep cirque wall and is at an altitude of about 4,500 feet, which is 1,500 feet above the camp in the valley bottom. In the neighborhood of the prospect aplitic dikes were seen in the "granite." The "vein" is an aplitic or pegmatitic dike, in places 9 feet thick, striking N. 60° W. (magnetic) and dipping 52° NE. This rock is a whitish or pinkish quartz-feldspar rock, with a few scattered black minerals, hornblende, and apparently also tourmaline. The dike has been shattered and cemented by quartz, especially along the hanging wall, where there is locally 8 inches of vein quartz. Between this and the granite is a narrow gouge seam. The values appear to be associated with the vein quartz, in which small specks of sulphide minerals are visible. The granite wall is everywhere more or less decayed and is said to carry values.

Two small open cuts were made on the "vein" during 1910. A tunnel was to be driven during the winter of 1910–11.

The Conroy claims adjoin the Matanuska Gold Mining Co.'s property on the north. The prospects lie on a ridge separated from those of the Matanuska Gold Mining Co. by a small cirque. There has been no work done on these claims except a little stripping of loose rock from the vein or veins at several places. At one such place

the amount of quartz exposed is small. At another the indicated strike is N. 40° W. (magnetic) and the dip southwest. In attitude of the vein and appearance of the quartz this prospect corresponds with the commoner type of the district and not with the adjoining Matanuska Gold Mining Co.'s prospect, which is exceptional.

Outlying prospects.—Some claims have been located outside of the main quartz diorite area. Among them are the following:

The Lydell claim is in the pass between Willow and Fishhook creeks, on the contact of the quartz diorite and the mica schists. This claim was not visited by the Survey party. However, from reliable sources it was learned that there is a large quartz vein along the contact and a number of smaller quartz stringers in the schist. So far as at present known there are no important mineral values in this prospect.

The Miller claims are in the Little Susitna River valley. One on the east bank is about 2 miles below the mouth of Fishhook Creek. There is here a mass of quartz between 60 and 80 feet thick; the upper wall is brecciated and much-altered quartz diorite(?). The lower wall was not exposed. The trend of the quartz mass appears to be N. 20° W. (magnetic) and it is either vertical or dips about 28° SW. The locator is engaged in crosscutting the quartz. The "ore" is bluish-white fine granular quartz with sparsely scattered pyrite crystals. So far as known the ore carries no gold values. The occurrence is most probably a quartz-filled brecciated fault zone. It is said to be traceable for 3 miles along Little Susitna River.

Mr. Miller has another claim on the west side of Little Susitna River about 3 miles below Fishhook Creek. This was not visited and no satisfactory information about it was obtained.

SUGGESTIONS FOR FURTHER PROSPECTING.

The prospects thus far located around the heads of Craigie, Willow, Fishhook, and Fair Angel creeks are all high on the cirque walls or narrow ridges between cirques. There seem to be two reasons for this restriction in area and altitude. First, the prospecting has been limited to the region nearest to and most readily accessible from the supply point, Knik. Second, the lower slopes and creek basins have been mantled by glacial débris, talus, and moss, which make the surface-examination method of prospecting practiced in the district impossible at lower altitudes. The ridge crests on which the prospects are located have been exhumed by glaciation from considerable depths, and it is probable that the phenomena of fracturing and veining thus exposed are present at lower altitudes also. The wide extent and persistent character of the joint systems, so strikingly apparent in the surrounding mountains of the same country rock,

suggest that some of the veins associated with the joints may also have as wide a distribution, both areally and at lower levels, and that at a given locality there may be veins at several elevations. For these reasons, and because the veins are not steeply inclined, prospecting by drilling and sinking shafts appears advisable.

GOLD PLACERS.

The placers are on Grubstake Gulch and on Willow Creek below Grubstake Gulch, both along the creek and on a bench on the south side (left limit) of the creek. Placer gold has been mined in commercial quantities at only one locality within the region—that is, on Grubstake Gulch. Willow Creek proper was staked by M. J. Morris and L. Herndon in 1898, and it is reported that they extracted about $4,000. In 1899 A. Gilbert staked Grubstake Gulch, and in 1900 he sold his interest to O. G. Herning, who manages the property for the Klondike Boston Mining Co., of Boston, Mass. This company also controls ground on Willow Creek and a bench below Grubstake Gulch. W. E. and E. H. Bartholf own most of the other claims on Willow Creek near Wet Gulch and below.

Grubstake Gulch is a glaciated hanging valley tributary to Willow Creek. Near its mouth a rim of bedrock crosses the channel and is cut through by the present stream, which falls precipitously for about 150 feet in a very short distance and enters Willow Creek at low gradient. An excellent dump for hydraulicking is thus afforded. The bedrock is a mica schist penetrated by small veinlets of quartz, both across and parallel to the schistosity. The parallel veinlets or lenses are the more abundant. Some of them have a pegmatitic aspect, but this could not be established in the rusty, weathered field specimens. The schistosity on the gulch has a strike about N. 60° E. (magnetic) and a dip of 40° N. The direction and inclination of the beds across the stream and the dip downstream are especially favorable for the collection of any gold that might have been concentrated from the rocks in the process of erosion.

Mining was begun above the falls. In the years 1904 to 1909, during which hydraulic methods have been in use, 1,200 feet of the creek with an average width of 200 feet and a depth from 2½ to 9 feet and locally (on the terrace on the west side) 12 feet have been worked out. The bedrock slope is about 1 to 24, or flume grade (6 inches to the 12-foot box). About one-third of the gold is coarse and rough, averaging one-tenth inch in diameter; the balance is moderately fine. The gold assays at the mint $16.58 an ounce. Very little black sand is found. In the lowest portion of the pay streak the gold was on a clay above bedrock, but higher up the creek the clay was absent. The greater part of the gold occurs close to or in crevices

of the bedrock, but it is not deemed necessary to clean up by hand, the hydraulic giant being relied on to sweep all the gold into the boxes.

The wash, which is confined to the gulch bed—there being no bedrock bench, although the terraced surface of the gravels is spoken of as a bench—is coarse, ill sorted, and not greatly waterworn. The many large bowlders make it necessary to employ two men in breaking up and removing oversize and add materially to the cost of extraction. Three Hendy giants are installed on the property, two No. 2 and one No. 1. The No. 1 is not ordinarily used. Seven hundred inches of water with a head of 180 feet is brought three-fourths of a mile down the gulch. A 24-inch pipe at the intake dam is reduced to 9 inches at the giant, to which is fitted a 3-inch nozzle. Twelve hundred feet of sluice boxes have been built. These are 27 inches wide, 30 inches deep, with bottom boards 1½ inches thick and side boards 1 inch thick; the frames are 3-inch square timbers. Block riffles are used. The gravel is driven to the boxes by the giants, at least one of which is directed across the creek—that is, parallel to the bedrock crevices. Very little gold is caught below the fourth box, the greater part being retained in the second. Mercury is placed in the third, fourth, and fifth boxes.

During 1910 the Grubstake Gulch operators limited their work to the extension of their pipe line about one-fourth mile and making other preparations for hydraulicking the bench at the mouth of Grubstake Gulch.

A ditch was built a few years ago from Wet Gulch down the south side of Willow Creek for the purpose of exploiting terrace gravels along Willow Creek. This project apparently has been abandoned.

SUMMARY.

The Willow Creek region is an area about 10 miles square some 20 miles northeast of Knik, on Knik Arm of Cook Inlet, Alaska. It includes an area of quartz diorite which is intrusive into and surrounds a belt of mica schist in its southern part and which is overlapped by Tertiary sediments along the south border of the region. The quartz diorite is cut by a few small dikes of diabase and aplite. A regular system of definite and continuous plane joints has broken the quartz diorite into blocks roughly rhombohedral in shape. There are other less regular and persistent joints, and along some of both the regular and the less regular joints there have been movements, but there are no observed faults of large displacement. Quartz filling of the fractures and decomposition of the quartz diorite along the fractures are not restricted to any set of joints, but, so far as this investigation determined, seem to be more extensive along those irregular

fractures which are nearly vertical and trend approximately north and south, and along joints which strike approximately northwest (magnetic) and dip 20° to 40° SW. The latter is the most frequent veining and that which is of greatest importance to the region. The important prospects thus far located are on such veins, which are from 16 inches to 4 feet thick, and are demonstrably persistent through distances that warrant development. They carry small amounts of pyrite and other minerals and considerable free gold, much of which is visible in the quartz. So far as developments now show, the ores are free milling and high grade, and it appears not improbable that the mineral-bearing veins may be found over a wider area and at lower altitudes than those now located.

PLACER MINING IN THE YUKON-TANANA REGION.

By C. E. Ellsworth and G. L. Parker.

INTRODUCTION.

It is the object of this report to give a brief summary of the general progress of placer mining in the Yukon-Tanana region during 1910. The writers were engaged in a water-supply investigation of the Fairbanks, Circle, Tenderfoot, Eagle, and Seventymile placer districts of the Yukon-Tanana region, and incidentally some notes on mining operations were made. Much of the material embodied in this report, however, is due to information furnished by mine operators and others personally familiar with the conditions in the several districts.

The decrease in the value of the gold production of the Yukon-Tanana region from $10,720,000 in 1909 to $7,100,000 in 1910 can be attributed almost entirely to the drop in output from the Fairbanks mines, which in turn was due mainly to the fact that many of the richer placer deposits so far located have been worked out, although several other reasons of less importance contributed to the decrease. Every camp in the region furnished to a greater or less degree its quota of men and capital to the Iditarod district, and the increased interest taken in lode mining also drew many men away from the placers. There was also experienced in July and August the most severe drought that has occurred during that season since the beginning of water-supply investigations in this region in 1907. The successful operation of placer mines is so dependent upon the water supply that a shortage in that most important factor will inevitably result in a corresponding decrease in gold output.

FAIRBANKS DISTRICT.

GENERAL CONDITIONS.

The marked decrease in production in this district from $9,650,000 in 1908–9 to $6,100,000 in 1909–10 is due to several causes, chief among which is the fact that many of the richest pay streaks have been worked out. New discoveries and the tracing of old pay streaks have not furnished new ground sufficient to offset the amount worked out during the previous years. In other words, the district

is reaching the stage in its development that lies between the exploitation of the rich bonanzas and the installation of machinery for large-scale operations which make for economy in extracting the gold from the gravels. This period of decline is experienced by most placer camps, and the interval of lower production will be long or short according to the difficulties met in making a thorough investigation of conditions and in perfecting organizations for the purpose of applying equipment best suited to the recovery of gold from gravels carrying low values. The exodus of men and machinery to the new Iditarod country also operated to cut down the annual output of the district, for many experienced miners transferred their funds and personal attention to the new placer camp. It was estimated that 1,000 men followed the ice down the Yukon to the new strike and, although many returned later, a disquieting effect was produced which was felt throughout the season.

The scarcity of water for sluicing necessitated the closing down of a number of plants and a reduction of the force employed at many others. The data secured during the summer at a number of stations on streams in the district (see p. 181) indicate a relatively lower run-off during July and August than has been recorded for any year since stream-flow investigations were begun in this section, in 1907. Still another reason for the decrease in the gold output may be the greatly increased activity in prospecting and developing quartz lodes in this vicinity, which has diverted the efforts and capital of a considerable number of experienced operators from placer mining.

Mining methods and conditions were practically the same as in previous years, and no great advance was effected in reducing the high cost of working the gravels, but some steps were taken to develop dredging ground. It is estimated that in 1910 between 1,300 and 1,400 men were employed in actual placer mining in the district on about 140 claims.

GOLDSTREAM BASIN.

During the winter of 1909–10 and the summer of 1910 Goldstream Valley presented a lively scene of mining operations from a point near the head of Pedro and Gilmore creeks to "No. 17 below." Open-cut methods were used extensively in the upper portion of the valley, where the depth of the ground permits working in this manner. Two large open-cut plants, one on "No. 9 below" Pedro and the other on "No. 5 below" Goldstream, operated bottomless scrapers successfully. It is reported that the cost of working the ground was less than 30 cents a square foot, which is low for the Fairbanks district. Several other smaller plants operating on Pedro Creek also proved the economy of the open-cut method of mining. The usual practice of drifting and hoisting was employed exclusively on lower Goldstream

and Engineer creeks. Probably 90 per cent of the production of the Goldstream Valley was secured in this manner. In size the plants ranged from a hand windlass worked by 2 men to a 60-horsepower steam plant employing 40 men. Some difficulty was experienced on Engineer Creek with thawed ground and underground water, but the most serious drawback of the season in this basin resulted from the scarcity of water for sluicing. Several of the mines working on low-grade gravel were compelled to shut down entirely on this account, and a number of others were not able to work a full force during the low-water period.

Successful prospecting on the second tier of benches on the left side of Goldstream, opposite "No. 8 below," early in the spring led to the development of a good pay streak extending over three claims opposite "Nos. 7, 8, and 9 below" later in the season. Considerable prospecting was done during the summer and is still being done to trace the pay gravel farther up and down stream. Bedrock on the second tier and creek claims is at about the same elevation, but the pay streak above the former seems to be of a uniformly higher grade than in the creek bed. The depth of ground, however, is somewhat greater on the bench claims, as the average depth of hole is between 100 and 110 feet. It is estimated that 500 men were employed in placer mining on 52 claims on Goldstream, Engineer, Pedro, and Gilmore creeks during the winter season and probably about 20 per cent more were working during the summer months.

CHATANIKA RIVER BASIN.

Cleary Creek.—A large percentage of the annual gold production of the Fairbanks district continues to come from Cleary Creek, which has produced more gold than any other creek in the Yukon-Tanana region. The settlement of the legal status of "Nos. 4 and 5 below" in 1909 made it possible to resume working in the richest part of the creek. The large plant on "No. 5 below" employed between 50 and 60 men. Practically all the claims from "No. 10 above" to "No. 17 below" on Cleary were being worked during the winter, and in the spring there were between 40 and 50 large dumps to be sluiced with the spring run-off. The summer operations, though not so extensive on the upper portion of the creek, were of greater magnitude than those of the winter season on the lower portion. This was largely brought about by the Chatanika ditch, which furnished eight operators with all the water that was needed for sluicing. Several of the operators made use of electrical energy supplied by the Poker Creek power plant for pumping the water from the ditch to their sluice boxes set at a higher elevation.

Wolf Creek, which was prospected rather thoroughly in 1909, began to yield good returns in the spring of 1910. Both open-cut and drift-

ing methods were employed in extracting the gold. The success attained by several small outfits engaged in "sniping" during the summer drew attention to the possibility of profitably working over the old tailings. It is conceded that the ground on Cleary Creek is of too great depth to work by hydraulic methods; but it is thought by local men that the gold remaining in the tailing piles amounts at least to 10 per cent of the quantity already recovered and that it might prove profitable to resluice the tailings with suitable appliances if the water from Chatanika River could be diverted to the ground at sufficient elevation and at a cost to warrant such an undertaking.

On Cleary Creek and tributaries between 45 and 50 outfits were working on about 30 claims during the winter.

Dome Creek.—A great decrease in mining operations was shown on Dome Creek, which has held a very prominent position among the producing creeks in past years. This is due chiefly to the exhaustion of the richest claims; but the fact that several of the claims are tied up in court proceedings is also an important factor. There were six or seven plants being operated between "No. 7 above" and "No. 7 below," of which only two on "Nos. 5 and 6 below" were working on a scale comparable to past operations. The extreme drought also added to the difficulties on this creek. It is said that there was scarcely enough water to supply a boiler on "No. 6 below" during the low-water period, where in former seasons there was very seldom less than a sluice head available. Further prospecting this year between "No. 7 below" and "No. 14 below" has failed to locate the "lost" pay streak in this part of the creek.

Chatanika Flats.—On lower Dome Creek, in the Chatanika Flats, the successful operation of a plant on the Niggerhead group and prospecting on the lower end of the group has defined a body of pay gravel at a depth of 180 feet which carries good values. Prospecting is also being done on the Recorder Association claim, which is just above the Niggerhead group and extends up Chatanika River, on the assumption that the pay comes from the river rather than from Dome Creek. Mining was being carried on at the mouth of Vault Creek on the Alabama Association claim, and about 4 miles below this point, near the mouth of Sargent Creek, gravel was being taken out from a 150-foot face which is 230 feet below the surface of the ground. The values are found on a false bedrock consisting of an impervious clay which is 89 feet above the real bedrock. It is thought by some of the miners that the developing and prospecting that have been done along the Chatanika Flats indicate a continuous pay streak from the mouth of Cleary down to Our Creek.

Little Eldorado Creek.—It is reported that a 20-ounce gold nugget was found in one of the clean-ups of a plant on the Idaho group of

Little Eldorado Creek. Considerable money was spent in prospecting on this creek last year without adequate results.

Homestake Creek.—The shallow gravels of the tributaries at the head of Chatanika River are suited to the method of hydraulicking in vogue in the Circle district. The small hydraulic plant installed on Homestake Creek this spring was in readiness for "piping in" early in July, and a good showing was made, considering the drawback that was experienced through low water. The water was diverted from Homestake Creek near its head and conducted by ditch and hydraulic pipe for about 3 miles along the right side of the creek to a point near the mouth, where mining operations were begun. The head attained is 160 feet and the depth of gravel to be worked averages about 8 feet.

CRIPPLE CREEK BASIN.

Ester Creek.—Mining operations are decidedly declining on Ester Creek, which in past years has yielded a percentage of the total production in the Fairbanks district second only to Cleary Creek. This is due principally to the fact that most of the richest portions of the creek have been worked out, but the lack of sufficient water for sluicing on Ready Bullion and upper Ester during the period of drought is also a contributing cause. The scheme of winter sluicing which was mentioned in last year's report was employed by three plants on Ready Bullion that were working in thawed ground. The plant on "No. 3 above first tier," which operated continuously during the winter, was visited by the writers early in the spring. A brief description of this plant will be given, as it affords an example of mining by the combination of thawed-ground and winter-sluicing methods. This is an unusual practice, for either condition is thought to considerably increase the cost of working ground. A 100-foot shaft to bedrock was joined by a system of tunnels, extending parallel and perpendicular to the course of the creek, which blocked out the gravel to be worked into 50-foot squares on the bedrock level. The supports for the small spruce pole shoring used for supporting the weight of the gravel consisted of uprights about 5 feet long and caps about 6 feet long hewed from spruce timber 10 to 12 inches in diameter. These were set 4 feet apart so that the poles, which were 8 feet long, could be driven ahead as the work on the face proceeded. It was not found practicable to pull this timbering, although the blocks farthest from the shaft were worked first and the ground was allowed to settle behind the working face. The gravel was conveyed from the face to the bucket hoist on cars of six wheelbarrows capacity, running on rails. A 3-inch pump kept the mine drained and by turning the exhaust into the sump hole warm water was furnished for sluicing. The exhaust from the steam hoist was conducted along

the bottom of the sluice boxes by use of canvas cover and aided materially in keeping the temperature above the freezing point. The sluice water drained from the tailing pile into a stilling reservoir and was again warmed by the exhaust from the pump, which raised it to a flume. The water was led back to the sluice boxes through this flume and was there joined by more water from the drain pump in the mine to begin a new circuit. No difficulty was experienced in operating, even when the thermometer stood at 60° below zero. It is interesting to note that the cost of working ground in this manner was claimed by the operators to be about 75 cents a square foot on a basis of weekly running expenses, not, however, taking into account interest, depreciation, etc. Sixty men were employed and between 5,000 and 5,500 square feet of bedrock was worked out weekly.

Winter operations on Ester Creek proper consisted of blocking out ground for summer work and taking out dumps to be washed up in the spring. It is estimated that there were about 200 men employed on about 17 claims of Ester Creek and tributaries during the closed season. No data are available for estimating the summer work, but it is thought that it was not nearly so extensive. The largest plant of the creek, working on "No. 3 below" and employing about 60 men, was compelled to discontinue work during the later part of the season on account of the laborers demanding $6 a day instead of the customary wages of $5 a day.

Prospecting opposite "No. 6 below," 1,500 feet to the right of the present pay streak, brought to light some very rich coarse gold prospects which are similar to the gold found on the right side of "No. 2 below." As this gold is very unlike the finer values found in the creek claims, further prospecting is under way to determine whether there is another old channel, curving to the right, which carries this coarse gold.

St. Patrick, Emma, and Alder creeks.—Very little actual mining was done in 1910 on St. Patrick, Emma, and Alder creeks, which are small tributaries of Cripple Creek.

FISH CREEK BASIN.

Fairbanks Creek.—Fairbanks Creek, though not a large producer, has yielded a steadier annual output than any other creek in the district. Mining by both open-cut and drifting methods was carried on from "No. 10 above" to "No. 11 below." Six or seven open-cut plants were in operation, most of which employed bottomless scrapers for stripping the ground and steam hoists for carrying the gravel to the sluice boxes. On "No. 3 below" a 45-horsepower bottomless scraper, having a capacity of 2½ cubic yards, was in use. There were a number of small operators employing a windlass for taking out the pillars and walls of gravel that were left in ground previously

worked by larger plants. The scarcity of water in July and August made it necessary for several of the plants to work alternately day and night, so that the total flow of the creek could be utilized by each plant. Winter sluicing, which has been successfully conducted during the last two years, will be employed again this winter by three of the operators. Prospecting on "No. 11 above" in former years had been confined chiefly to the left side of the claims, but in 1910 some very good values were obtained in holes sunk on the right side. Crosscuts were run and further prospecting carried on during the later part of the summer to determine the extent of the high-grade gravel, but it was not learned what success attended these efforts. Summer development and prospecting has also resulted in the location of a body of gravel carrying values on claims of lower Walnut Creek and on the adjoining left-limit bench claims opposite "Nos. 1 and 2 below" of Fairbanks Creek. It is estimated that about 135 men were employed on 20 claims in this drainage basin during both the winter and summer seasons.

In the past there have been several large-scale plans under consideration which involved the use of a dredge for working the ground on Fairbanks Creek, and options on claims have been taken with that end in view, but so far as known nothing definite has been done toward putting these plans into effect. A number of owners are securing patents to their claims which insure absolute title and will simplify their relations with a dredging company, if one is organized.

Fish Creek.—A decided increase in mining operations has taken place on Fish Creek during the last year, and developments this summer seem to indicate that it will remain on the productive list for some years to come. A number of operators on the upper part of the creek who took out winter dumps were very agreeably surprised when their clean-ups netted more than they were expecting. This was due largely to the presence of coarse gold, which had not been found to any great extent in prospecting. It is reported that a $43 nugget was found in the spring clean-up of "No. 5 above," and later in the season the operators on "No. 2 above" are said to have taken out a nugget valued at $84.25. Previous to this spring it was thought that Fish Creek would produce chiefly fine gold.

Mining was being done on almost every claim from "No. 10 above" to "No. 2 above" by both open-cut and drifting methods. "Nos. 2 and 3 above" yielded the best returns for the summer season. Below "No. 2 above" there was some prospecting done, without success, in trying to locate a pay streak between this claim and "No. 8 below," where one outfit, employing four men, was occupied in drifting in gravel carrying fine gold. About 35 men were employed on eight claims during the winter, and it is probable that about 50 men were employed during the open season.

CIRCLE DISTRICT.

GENERAL CONDITIONS.

The success of the small hydraulic plant on Eagle Creek and the fact that Mammoth Creek has been put on a productive basis through the satisfactory operation of the larger plant installed there during the summer of 1909 has given an added impetus toward hydraulicking in this district. The character and depth of gravel and the nature of the bedrock of portions of the stream carrying values are favorable to this method of mining, provided sufficient water can be had at an effective head. The gradient of the streams, however, is not sufficient for disposing of the tailings without some system of stacking. A giant is used for this purpose in connection with the two plants mentioned above, which necessarily calls for an additional supply of water. In this district there are four or five projects under consideration which entail the use of water under a head for their development, and it is hoped that two of these will be in operation before the close of the season in 1911.

The economy attained in moving gravel by the two plants now in operation during the extremely dry season of 1910 and at relatively high elevations lends encouragement to those who look forward to mining the low-grade gravels in the Birch Creek bars and along Preacher Creek with the considerable volume of water which would be available for that purpose. It should be borne in mind by those contemplating the installation of plants that this district embraces an area of low run-off, and accordingly the water supply available for each project should be carefully determined.

A renewed interest in locating new pay streaks has been brought about by the small strikes on Bottom Dollar and Frying Pan creeks, and if the summer operations on Buckley Bar of Birch Creek proper prove successful doubtless attention will be again directed to this field of endeavor.

The transportation facilities for summer traffic were not greatly improved this season on account of lack of funds. The only substantial improvement in the roads consisted of laying corduroy across the Albert Creek swamp, which separated the Government road, as completed in 1909, from the Central House. The dry weather, however, made it possible to haul larger loads over the unimproved trails from Central House to Deadwood and Miller House than for a number of years in the past.

The district as a whole suffered somewhat from scarcity of labor during the fore part of the season, owing chiefly to the false report that there was a great need for laborers in the Fairbanks district and that wages there had been advanced to $6 a day.

CROOKED CREEK BASIN.

Mastodon Creek.—A livelier scene of small-scale mining operations was presented during the summer by Mastodon Creek, from "No. 7 above" to its head, than by any other part of the district. Here the depth of gold-bearing gravels is such that the open-cut method of mining is better suited for extracting the values than winter drifting. It is estimated that 85 men were employed in this section of the creek on 12 claims through most of the summer season, though only 16 men were working on about six claims during the winter. Two of the largest operators, employing about 25 men each, made use of bottomless scrapers for removing the overburden and bringing the gravel to the boxes. On "No. 21 above" a water wheel furnished the power for hoisting the gravel into the sluice boxes.

The title to the claims on the lower part of the creek from "No. 2 below" to "No. 7 above" has been secured by a company which proposes to divert water from Mastodon and Independence creeks for working the claims with small hydraulic elevators. A considerable part of this ground has been worked over during the last 10 years, but on account of the costly methods employed only the richest portions have yielded profits. The lower-grade gravels left at intervals in the creek bed and along the sides of the claims should net good returns if economical means of handling the gravel are provided. The company landed a 300-ton outfit, consisting principally of hydraulic pipe, at Circle before the close of navigation, and if plans are fulfilled the plant will be in readiness for operating early in June, 1911. As the quantity of water is an important factor to be considered, it is thought that the use of pipe for conveying the water to the elevator pits will make it possible to begin sluicing earlier in the season and that thereby a greater percentage of the spring run-off may be utilized. Furthermore, the pipe can be used again in other localities under similar conditions. "No. 6 below," upon which six men were employed, was the only claim that was worked on the lower part of the creek.

Mammoth Creek.—The largest hydraulic plant of the Yukon-Tanana region was in operation on Mammoth Creek. Here water was diverted from Bonanza and Porcupine creeks at an elevation of about 2,350 feet and conducted to the left bank of Mammoth Creek by a ditch 10.3 miles long. The lower part of the ditch below the Bonanza intake, 6.5 miles long, was constructed in 1908 and put into good working order in 1909. A portion of the Porcupine branch of the ditch was dug in 1909 and the ground along the remainder of the ditch line was stripped of moss to allow the underlying frozen muck to thaw. Much difficulty was experienced in completing this section of the ditch last summer on account of ground ice along the steep

slopes near the Porcupine intake. Wherever the ditch line crossed these pockets of nearly clear ice, the ice was kept exposed to the open air and a drain provided to expedite thawing. This process of thawing quickly opened up a good-sized hole in the side of the hill, and when it was possible to provide a good foundation the space below the ditch was filled in with layers of moss and dirt. This ditch was built to a grade of 5.3 feet per mile with a width of 6.5 feet on the bottom. The usual form of construction, which consists of making the bottom of a ditch level, was not followed in building the upper ditch. The method adopted constitutes digging the side next to the hillside five-tenths deeper than the embankment side. When carrying water, a ditch with this cross section will have its greatest depth next to the hillside, and as the highest velocity of a stream or ditch is usually at the deepest section it is thought that the tendency of the water to cut the embankment will thus be decreased.

Operations on "No. 7 below" were carried on by the method of "piping in," a detailed description[1] of which has already been published. A head of 375 feet is available, but only 270 feet on bedrock was used. The completion of the Porcupine branch and the maintenance of the lower ditch kept 17 men busy during the summer and 14 men were employed at the mine. Low water proved to be the most serious drawback to the operations of the season. Data concerning the amount of water available at each intake may be found on page 200. Since a reservoir was not provided the method of sluicing intermittently, as practiced on Eagle, could not be employed on Mammoth. By reducing the size of the nozzle, however, it was found possible to work to an advantage during most of the low-water period, as only five days in July were lost through inadequate water supply. Frozen ground also offered considerable inconvenience, but doubtless the scheme adopted of stripping the gravel ahead of the pit a year in advance of operations will do much toward averting this difficulty.

Deadwood Creek.—Mining operations on Deadwood Creek during the winter of 1909 and summer of 1910, though handicapped on account of the low water, were about the same as in the previous two years. Here there seems to be no tendency toward adopting methods leading to a reduction in the cost of extracting the gold. The fact that most of the claims are worked by one to three men with pick, shovel, and hand windlass as the only labor-saving devices makes it evident that ground worked at a profit in this manner would pay well if more extensive equipment were provided. If the increased activity in hydraulicking in other parts of the district proves successful no doubt this method can be applied advantageously in working

[1] Ellsworth, C. E., Placer mining in the Yukon-Tanana region: Bull. U. S. Geol. Survey No. 442, 1909, p. 237.

the Deadwood deposits. The water supply available for this purpose above Switch Creek is stated on page 200. During part of the season good results were obtained from the operation of an automatic dam about a mile above Discovery claim. Considerable difficulty was experienced on the upper part of the creek with the "glacier," which formed on the claims during the winter to a depth of 15 feet in places and which did not disappear until late in July. Since there was very little water in Switch Creek after the spring thaw, operators were compelled to shut down work soon after the winter dumps had been sluiced. Information collected indicates that about 30 men were occupied in mining on 16 claims during the open season and that about 20 men worked 14 claims in the winter.

Independence Creek.—Mining on Independence Creek was carried on from "No. 5 below" to "No. 13 above" by 22 men working on six claims during the summer. Winter operations consisted of eight men drifting on six claims. Pick and shovel methods are used in working the deposits during both the open and closed seasons. It is reported that eventually the lower part of the creek will be hydraulicked by the company which has gained control of the lower portion of Mastodon Creek.

Miller Creek.—There were practically no mining operations on Miller Creek during the year. The ownership of all the claims from the mouth of the creek, "No. 7 below," to "No. 21 above" has come under the control of a company which proposes to build a ditch and work the ground with methods similar to those used on Eagle Creek. As the depth to bedrock is only 6 to 7 feet at the upper end of the creek and 12 to 14 feet on the lower end, little difficulty should be encountered in stacking the tailings. Owing to the meager water supply of Miller Creek (see p. 201) it will probably be necessary to provide a reservoir for storing the water so that it can be used intermittently during periods of drought, as is done on Eagle Creek. Ten men were employed during the later part of the summer stripping ground for a ditch, so that the large crew of men to be employed in the spring can carry the work on to completion. It is hoped that the plant will be ready to make use of the spring run-off in 1912.

NORTH FORK OF BIRCH CREEK BASIN.

Eagle Creek.—Hydraulicking on Eagle Creek was an experiment when first begun during the summer of 1908. The successful operation of the plant there during the last two seasons has shown conclusively that a small outfit and a small water supply can give good results when managed properly. It is estimated that ground carrying values as low as $1 a cubic yard can be worked to a profit with this method and under similar conditions—a fact which makes it evident that there are a number of deposits of gravel in the Circle

district that would render good returns if this same means of exploitation could be employed.

The use of a small reservoir above the Mastodon Fork intake of the ditch made working on a small scale possible even during the excessively dry period in the middle of July, when the mean daily supply delivered by the ditch was probably less than 2 second-feet (80 miner's inches). The system used involved allowing the reservoir and ditch to fill and drawing on the storage thus supplied to operate the giants until both were emptied. It was only possible to work with about 500 miner's inches for two hours to the shift while the water was at its lowest stage. Seven men were employed to operate the plant during the summer.

Harrison Creek.—There were no operations on Harrison Creek proper during the last season, but it is reported that a hydraulicking project is being contemplated. Winter prospecting in 1909–10 on Bottom Dollar Creek and its tributaries, Half Dollar and Two Bit Gulch, resulted in locating some good prospects, and several small dumps were taken out which netted good returns when sluiced in the spring. It is understood, however, that the pay streak was found to be narrow and the gold contained in it irregularly distributed. Two men worked on the creek during the summer.

McLain Creek.—Two men were employed in operating an automatic dam on McLain Creek, which flows into Birch Creek just above Deadman Bar, but the work was hampered through lack of water. If a body of gravel of sufficient extent and of sufficient gold content can be located at this point to warrant the building of about 15 miles of ditch and to provide suitable hydraulic equipment, it is thought that an abundant water supply can be diverted from Clums Fork, which would give a working head at the mouth of McLain Creek of about 200 feet. A measurement of Clums Fork at the mouth on July 25, during a medium stage, gave a discharge of 118 second-feet (4,700 miner's inches).

Fryingpan Creek.—During the winter three prospectors located good values in a hole sunk to bedrock on the left side of Fryingpan Creek about one-half mile below the forks. The ground at this point is about 20 feet deep, comprising 15 feet of overburden and 4 or 5 feet of pay gravel. A small ditch was built and prospecting continued during the summer.

PREACHER CREEK BASIN.

The only mining done in the Preacher Creek drainage basin consisted of installing and operating an automatic dam on Bachelor Creek just below Costa Fork in the later part of the season. The scheme to work the Bachelor Creek gravels by the use of hydraulic lifts, which led to expending considerable money in partly construct-

ing a ditch in 1909, has apparently been abandoned. It is reported that large bodies of low-grade gravel exist in the Preacher Creek valley below the mouth of Bachelor Creek which could be conveniently worked by some system of hydraulicking. A low-water measurement of 45 second-feet (1,800 miner's inches) above the mouth of Bachelor Creek seems to indicate that there is sufficient water for this purpose.

BEAVER CREEK BASIN.

Prospects were found in the upper tributaries of Beaver Creek which led to the staking of considerable ground long before the Fairbanks district was developed, but no actual mining operations were carried on in that vicinity. Desultory prospecting in later years seemed to indicate that the gold content of the gravel is very irregularly distributed and that it is not extensive enough to warrant any considerable outlay of capital.

During May, 1910, some good values were found, however, on Ophir Creek, a tributary to Nome Creek, which resulted in starting a small stampede about the middle of July. All of the ground in the Nome and Trail Creek drainage basins was staked, as well as that on several other creeks near by. Systematic prospecting followed in the wake of the stampede, and if reports are to be relied upon pay streaks have been located on Nome Creek above Ophir and on Ophir Creek near its mouth. Bedrock drains were being established on upper Nome Creek during the summer by an outfit which proposes to operate a bottomless steam scraper next season. The ground is all shallow, averaging about 15 feet deep, with 2 to 4 feet of pay gravel, so that open-cut methods will no doubt prove to be the cheapest means of recovering the gold. Ophir Creek, which flows into Nome Creek about 2 miles from its mouth, was the scene of the liveliest excitement during the stampede. On Discovery claim a 50-foot crosscut was run to determine the width of the pay streak, and it is stated that this was traced for a length of five claims before the close of the open season. The gravel carries coarse gold values at about $17 an ounce, and it is reported to run from $1.25 to $1.75 a square foot. The largest nugget found was valued at $4.30. Some very encouraging values were found on Trail Creek, which heads opposite Poker Creek, flows for about 15 miles in a northeasterly direction, and joins Beaver Creek about 6 miles below Nome Creek. Prospects were also found on several newly named creeks, such as Dominion Creek, Gold Mountain Creek, and Hoosier Creek, the locations of which were not learned by the writers.

There was much complaint registered against the laws which make it possible for one man, with the power of attorney from others, to stake association claims. It is said that 12 miles of creek was staked by one man in this manner.

HOT SPRINGS DISTRICT.

The value of the gold production in the Hot Springs district for 1910 is estimated to be approximately $325,000, which is the same as that estimated for 1909. The increased output from Sullivan and Cache creeks offsets the decrease from the Baker Creek mines.

It is understood that a large quantity of machinery has been shipped into the Patterson Creek basin, and the lack of capital, which has seriously retarded the proper development of the mines since the discovery of gold in this section in 1907, was not so marked during the last season as in previous years. It is reported that stream tin has been found in considerable quantities at nearly all the mines in this basin and that an investigation will be made relative to the possibility of saving that metal in connection with the recovery of the gold. It is believed, however, that the value of the presence of that metal lies in its indication that a ledge may exist, which, if located, might be worked at a profit. Sluicing in the basin opened May 10 on Tofty Gulch, where a prosperous season was reported. The overburden was groundsluiced off, and the auriferous gravel carried to the sluice boxes by a steam scraper. On Sullivan and Cache creeks new deposits of pay gravel are continually being located. Considerable difficulty has been caused by lack of sufficient sluicing water, and pumping has been resorted to on several claims in order to return the water to the head of the sluice after passing through. A few men were also mining on Quartz Creek during the summer.

On Thanksgiving and Pioneer creeks, where open-cut methods are used almost exclusively, a greater quantity of water is necessary for the successful operation of the mines than in those sections where deep-mining methods are practiced. The extreme drought, together with the losses due to carrying the water in ditches for several miles, caused the suspension of operations during a greater part of the season. On Eureka Creek claims "No. 7 above" to "No. 3 below" were worked by a Bagley bottomless scraper. The ground averaged about 12 feet deep and favorable results were reported, although some difficulty must have been experienced from the prevailing scarcity of water.

RAMPART DISTRICT.

The estimated value of the gold output from the Rampart district in 1910 was $43,000, about equally divided between winter and summer production. It was less than half the estimated output for 1909, and the decrease was undoubtedly due mainly to the fact that the richest pay streaks are about worked out, although a small decrease can be attributed to the closing down of the hydraulic plant on Hoosier Creek. It is estimated that 33 men were employed in

mining on 18 claims during the winter of 1909–10 and 42 men on 15 claims in the summer of 1910. The chief development in the district during the past season was the introduction of a steam-shovel plant on Hunter Creek which was in operation near Discovery. Little Minook continues to be the chief producer and Hunter Creek comes second in output. Quail Creek takes third place, showing a larger production than for any year in the past, and if economical mining methods are introduced the creek promises to be one of the chief producers of the district. Some mining was also done on Little Minook Junior, Slate, Hoosier, and Big Minook creeks. It is reported that good prospects have been found on Hosiana Creek and in the fall of 1910 about 50 men were prospecting in the vicinity.

SALCHA-TENDERFOOT DISTRICT.

Tenderfoot Creek.—Renewed activity in mining operations on Tenderfoot Creek resulted from the location of good pay on bench claims opposite "Nos. 6 to 9 below." The appearance of the schist bedrock and the character of the wash indicate a higher channel which carries coarser gold than that found in the creek claims. Since the depth of the ground on this creek varies from 30 feet at "No. 1 below" to 180 feet at "No. 17 below" only drifting methods can be used for extracting the values. Small outfits were distributed rather irregularly along the creek from "No. 1 above" to "No. 14 below" and mining was being carried on during both the open and the closed season. The summer operations were greatly handicapped, however, through scarcity of water for sluicing. On an average between 25 and 30 men were employed on 10 claims throughout the year.

Banner Creek.—Very little mining was done on Banner Creek proper during the year, but considerable work was done on Democrat Creek, an upper tributary. The production of "Nos. 1 and 2 above" Democrat Creek represents a very large percentage of the total output of the creek. The depth of ground on these claims permits the use of open-cut methods. Two small outfits were also mining on Buckeye Creek.

Salcha River tributaries.—Actual mining operations in the upper Salcha basin were confined to No Grub and Caribou creeks. It is understood that very good returns resulted from the season's work in spite of the difficulties encountered in this section due to thawed ground and underground water. It is estimated that 20 men were employed in mining on about five claims. Seven men were occupied in prospecting on Twentymile and Butte creeks and about 10 men busied themselves in hunting pay gravel farther toward the head of Salcha River.

FORTYMILE DISTRICT.

GENERAL CONDITIONS.

Although no water-supply investigations have been carried on in the Fortymile district prior to 1910, it is believed that the stream flow for the summer reached an extremely low stage, and the decrease in the value of the gold output from $225,000 in 1909 to $200,000 in 1910 can be attributed almost entirely to the inadequate supply of water for mining. No new developments were introduced during 1910, and the mining methods used were practically the same as have been in vogue for several years. The possibilities of economically recovering the gold by means of dredges have been seriously studied, and since 1907 five different dredges have been installed on Fortymile River and its tributaries. The experience derived from their operations should be of incomparable value to those contemplating the introduction of such methods elsewhere in the Yukon-Tanana region, where conditions in a general way are very similar. Perhaps as a whole they have not proved to be a financial success, and sufficient information is not available to determine the reasons for the failures which have occurred. It is probable, however, that failures are in a large measure directly chargeable to lack of thorough prospecting on the part of the promoters to determine the gold content of the ground. The value of thorough prospecting by those vitally interested can not be too much emphasized, for it shows not only the value of the gold that can be obtained from the unit quantities of gravel to be mined but also the suitability of the ground for dredging. No hydraulic development of any magnitude has been instituted in this district, but it seems reasonable to predict that eventually such means will be employed to a considerable extent. It is hoped that the investigations relative to the water supply which are being carried on in the district will prove of value in considering the feasibility of the several projects and that failures due to a lack of sufficient water may be largely eliminated by such information. A summary of the stream-flow data gathered in this district during 1910 can be found on pages 202–209.

MINING OPERATIONS.

Walker Fork.—The dredge on Walker Fork near Poker Creek had an exceptionally prosperous season. Some trouble was encountered during the earlier part of the summer in frozen ground and steam points were used to thaw ahead of the dredge, but it is understood that after the middle of July no further difficulties were experienced in that respect. A gang of men was kept at work stripping the ground that will be worked another season, and it is expected that by so doing the ground will be thawed ready for the dredge. The

dredge is steam driven and the fuel supply, which is wood, has become so depleted that it is now necessary to haul it several miles, making an excessive cost, which on some ground might prove so dear that operations would be conducted at a loss.

Considerable work was in progress on both Davis and Poker creeks and about six or seven men were working on each creek. The gold was recovered by groundsluicing and shoveling into sluice boxes. No winter work has been done on either creek, aside from propecting.

Two men were engaged in prospecting Walker Fork below Cherry Creek in order to determine the feasibility of dredging in that vicinity, but the results are not known. Some prospecting was also done on Cherry Creek.

Canyon and Squaw creeks.—On Canyon Creek about 3 miles below Squaw Gulch a steam scraper of one-half yard capacity, drawn by a 45-horsepower boiler connected with a double-drum hoist, was in operation during the later part of the season. It is claimed that 150 cubic yards could be handled per day of 10 hours. The ground averages about 7 feet in depth and is practically all gravel. The bedrock is slate and mica schist, and about 2 feet is moved in order to recover all the gold. A plowlike arrangement, operated by the same line of cables that is employed in hoisting the dirt to the sluice, is used to break up the bedrock so that it can be moved by the scraper. The plowing was done in the evening, and two or three men were able in a few hours to loosen all the bedrock that could be handled during the following day. Eight men were employed in connection with the plant. During the early part of the season a scraping plant of smaller capacity was in operation just below the mouth of Squaw Gulch.

On Squaw Gulch three or four outfits of one to three men each were mining by open-cut methods at times during the summer.

Wade Creek.—The production from Wade Creek in the summer of 1910 was greatly curtailed by a lack of water during most of the season. In the winter 18 claims were worked by 41 men, and during the summer 24 men were employed on 10 claims when the water supply was adequate. All the summer work was done by open-cut methods and was confined mostly to bench claims.

Chicken Creek and tributaries.—Although the lack of water for sluicing necessitated the suspension of operations on Chicken Creek during the greater part of the season, two outfits employing 6 men were drifting and 11 men were doing open-cut work on four claims for short periods throughout the season. Only one claim was worked during the winter and on this 10 men were employed.

The mining on Stonehouse Creek was about equally divided between winter and summer work. Ten different claims were worked by three men each. On Myers Fork seven men were mining on

claims Nos. 1, 2, and 5 at different times of the year. During the summer open-cut methods were used.

On Lost Chicken Creek five or six men were engaged in mining for most of the year.

Ingle Creek.—Reports from Ingle Creek indicate that considerable work was in progress, and about five men were engaged in mining during most of the year. Four claims were worked by drifting in winter and open-cut methods in the summer. Some work was done also on Lilliwig Gulch, which is a small tributary of Ingle Creek.

Franklin and Napoleon creeks.—Franklin Creek, the oldest gold-producing tributary of Fortymile River, is still being mined each summer by groundsluicing and shoveling into boxes. Very little was accomplished during July and August because of a lack of water, although six men were on the creek in readiness for work when the supply would permit.

Work on Napoleon Creek was also brought to a standstill by a lack of water during the greater part of the season, although two men recovered some gold in the short time that a sluice head was available.

Other streams.—Pay gravel has been found on Fortyfive Pup, a tributary of Buckskin Creek, at claim No. 13, and considerable ground was worked by two men under the prevailing difficulties attending mining operations in a small drainage basin during a dry season.

Hutchinson Creek and its two tributaries, Confederate and Montana creeks, are known to carry pay gravel, but the extremely dry weather of the season of 1910 practically eliminated all operations involving the recovery of gold, although considerable dead work was accomplished. Two automatic dams were built. Five men were in the basin during the summer.

Fortymile bars.—Gravels with a high gold content are said to occur on a bench of Fortymile River near the mouth of Twin Creek, which is a tributary from the north about one-half mile below Steele Creek. During the summer of 1909 a ditch was built which diverts water from Twin Creek a short distance below the forks. It has a length of 9,000 feet, a bottom width of 2 feet, and a grade of 6.9 feet per mile. A pressure of 150 feet is obtained, and it is planned to hydraulic the bench gravels. No mining was accomplished during the season of 1910, owing to a lack of water.

A small dredge designed more especially for prospecting was in operation for a portion of the season on a bar of Fortymile River near the boundary, but the details of the operation are not known.

On Atwater Bar, at the mouth of Atwater Creek, four men were mining during a considerable portion of the year, and it is reported that satisfactory results were obtained.

Owing to the low stage of the river during the summer the conditions were extremely favorable for the few men who were washing the gravel by the use of rockers.

Troublesome Point, opposite the mouth of Franklin Creek, is still the scene of mining, but very little was accomplished during the summer, owing to the fact that the water supply is derived from a small gulch back of the mine which could furnish a sluice head of water only during a period of extended rains.

SEVENTYMILE DISTRICT.

It is estimated that the combined gold output from the Seventymile and Eagle districts for the year 1910 was approximately $10,000. In the Seventymile district about 20 men were engaged in mining, but during the winter very little was done aside from prospecting. Early in the spring considerable local excitement was caused by the finding of some coarse gold on Rock Creek near its head. The depth of the ground is about 50 feet, composed almost entirely of muck. As the gold is concentrated on bedrock high values to the pan were obtained, but the aggregate value of the gold content per square foot of bedrock was too small for the ground to be worked at a profit. Several large boilers were shipped to the creek and prospecting was continued throughout the summer, but no more encouraging prospects were found.

During the summer of 1909 a ditch which diverts water from Sonickson Creek was constructed, but it was not put into use until last season, when the water under pressure was used to remove the overburden from the river bar above the falls. The ditch is 6,000 feet long and has a bottom width of 3 feet and a grade of 4.6 feet per mile. A pressure of 150 feet is available. A Ruble elevator was constructed but did not prove adapted to the conditions. The overburden was therefore hydraulicked into the river and the pay gravel shoveled into sluice boxes. On Curtis Bar a small winter dump was taken out and some work was done during the summer. Two men were also mining on a bar just above the falls, on the north side of the river, for a short time during the later part of the season. On Crooked Creek claims "Nos. 2 and 3 above" were worked by 10 men most of the summer. The overburden was removed by water under a 40-foot pressure. The water was carried in a ditch 2,200 feet long. A small ditch was also constructed for use in working Discovery and adjoining claims.

Mining on Barney Creek was confined to the operation of the small hydraulic plant which has been in use for several years, and two men were employed in the performance of the work.

During the summer about a mile of ditch was built, which diverts water from Washington Creek [1] near its head and carries it over the divide for use on Pleasant Creek, which is the first tributary of Seventymile River from the north above Barney Creek. It is said

[1] Washington Creek heads in the divide north of Seventymile River near Barney Creek and is tributary to Yukon River about 15 miles above Charley River.

that the benches on the right bank of Pleasant Creek carry gravels containing sufficient gold to mine at a profit if an adequate water supply could be obtained, but it is very doubtful if the quantity available in Washington Creek, at the elevation necessary to carry it over the divide by gravity, will be found to be of much assistance.

One man was working on Nugget Creek and one on Broken Neck Creek during the summer when the water supply would permit.

Values are reported to have been found on Alder Creek. The auriferous gravels so far located lie in or near the creek channel, where the depth of the ground averages about 4 feet. Nuggets valued at $19, $8.50, and $7 and several $1 and $2 specimens were found. Plans were made to do considerable prospecting on Alder Creek during the winter of 1910–11.

Two men were engaged in mining on Flume Creek near the mouth throughout the season. A reservoir and an automatic dam were built on the left-limit bench of claim No. 1. The water was carried to the reservoir in a ditch which was constructed several years ago.

EAGLE DISTRICT.

In the Eagle district mining operations were confined to American Creek and its tributary, Discovery Fork. On American Creek two automatic dams were installed—one on claim "No. 8 above" and one on claim "No. 2 above." At the upper workings an average of four or five men were employed the entire season, and after the completion of the dam considerable ground was worked. At claim "No. 2 above" the work was confined almost entirely to the construction of the dam and waste ditch and the opening of ground in preparation for another season. Some mining was also done on two other claims during a part of the season. Two outfits of two men each were working by open-cut methods on Discovery Fork.

MINOR YUKON RIVER DISTRICTS.

On Woodchopper Creek during the winter of 1909–10 three claims were worked, on which 15 men were employed, and during the summer of 1910 six men were engaged in mining on two claims. The value of the gold output for the year is estimated at $19,000.

Fourth of July Creek gave a production of about $6,000. Four claims were worked in the winter by 11 men and in the summer 12 men were mining on five claims. Both drifting and open-cut methods were used. One automatic dam was in operation.

On Coal Creek an average of about 20 men were engaged in mining during the year. A hydraulic plant was operated under a pressure of 160 feet. The water was diverted from Boulder Creek, which is a small tributary of Coal Creek. It is reported that values have been located on Sams Creek and that about 16 men were either mining or prospecting along the stream.

Two men were mining by open-cut methods on Surprise Creek, which is a tributary of Washington Creek.

WATER SUPPLY OF THE YUKON-TANANA REGION, 1910.

By C. E. ELLSWORTH and G. L. PARKER.

INTRODUCTION.

This report has been prepared to furnish for immediate use the essential results of the water-supply investigations in the Yukon-Tanana region during the season of 1910.

The work was begun in this region in 1907 and has been continued each succeeding year. The data collected in 1907 and 1908 [1] and their analyses have been published in detail. Those of 1909 [2] were presented in the progress report for that year in a form similar to the arrangement used in this paper.

The writers arrived at Fairbanks March 31, and until the later part of May the time was devoted to a study of winter run-off and mining conditions and to general preparations for the summer work. In the early part of June, after having commenced the investigations in the Circle district, C. E. Ellsworth proceeded to Eagle and began a study of the water supply in the Fortymile, Eagle, and Seventymile districts, where he continued work until the later part of September. G. L. Parker continued the work in the Fairbanks, Circle, and Salchaket districts during the remainder of the season and was assisted by T J. Shaw during July and August in the Little Chena River drainage basin.

On account of the large area to be covered, the slow means of transportation, and the needs and possibilities of the several districts, it was decided that the data would be of more value if the investigations in the Rampart and Hot Springs districts were discontinued and the remaining time devoted to a more thorough study of the conditions in the Fairbanks and Circle districts.

The writers desire to express their appreciation of the courtesies extended and aid given to the work by many residents of the region. Special acknowledgments for supplying gage readings are due to

[1] Covert, C. C., and Ellsworth, C. E., Water-supply investigations in the Yukon-Tanana region, Alaska, 1907-8: Water-Supply Paper U. S. Geol. Survey No. 228, 1909.

[2] Ellsworth, C. E., Water supply of the Yukon-Tanana region, 1909: Bull. U S. Geol. Survey No. 442, 1910, pp. 251-283.

Messrs. J. P. Carroll, Albert Carruthers, M. Danielson, J. T. Dickinson, August Fritch, Arthur Froelich, Mrs. A. Gustavason, Messrs. R. C. Hall, William Hugel, Alfred Johnson, J. F. Kelley, J. W. McCluskey, Jack McLin, Dan McPherson, Charles Martin, —— Michaels, Frank Miller, Frank Montgomery, Oscar Morrill, W. F. Munson, James Murphy, T. E. Phillips, C. A. Pihl, —— Powers, John Roberts, E. A. Robertson, Henry Siemer, A. F. Stowe, John B. Tait, Mrs. F. Warren, and Messrs. Robert Warren and John Williams.

MISCELLANEOUS MEASUREMENTS.

A number of miscellaneous measurements were made during the season of 1910 at points where it was impracticable to attempt to procure daily records.

A comparison of the run-off per square mile at the points where daily records were obtained shows a general trend of similarity, but the daily variations and in some cases the monthly departures from the general average are so great that extreme care should be used in making estimates from these measurements.

The season as a whole was characterized by considerable fluctuation in the stage of the streams, but most of the miscellaneous measurements were made during July and August, when the run-off was very low and the flow fairly uniform.

EXPLANATION OF DATA AND METHODS.

The methods of carrying on the work and collecting the data were essentially the same as those previously used for similar work[1] but were adapted to the special conditions found in Alaska.

In the consideration of industrial or mining enterprises which use the water of streams, it is necessary to know the total amount of water flowing in the stream, the daily distribution of the flow, and facts in regard to the conditions affecting the flow. Several terms are used—such as second-foot, miner's inch, and gallons per minute—to describe the quantity of water flowing in a stream, the one selected depending on the use to be made of the data.

"Second-foot" is in most general use for all classes of work, and from it the quantity expressed in other terms may be obtained. It is an abbreviation of cubic foot per second, and may be defined as the quantity of water flowing per second in a stream 1 foot wide and 1 foot deep at the rate of 1 foot per second. It should be noted that it is a *rate* of flow, and to obtain the actual quantity of water it is necessary to multiply it by the time.

"Second-feet per square mile" is the average number of cubic feet of water flowing per second from each square mile of area drained,

[1] See Water-Supply Papers U. S. Geol. Survey Nos. 94, 95, and 201.

on the assumption that the run-off is distributed uniformly, as regards both time and area.

"Run-off, depth in inches on drainage area," is the depth to which the drainage area would be covered if all the water flowing from it in a given period were conserved and uniformly distributed on the surface. It is used for comparing run-off with rainfall, which is expressed in depth in inches.

The "miner's inch," the unit used in connection with placer mining, also expresses a rate of flow and is applied to water flowing through an orifice of a given size with a given head. The head and size of the orifice used in different localities vary, thus making it a most indefinite and unsatisfactory unit. Owing to the confusion arising from its use it has been defined by law in several States. The California miner's inch is in most common use in the United States and was defined by an act approved March 23, 1901, as follows: "The standard miner's inch of water shall be equivalent or equal to 1½ cubic feet of water per minute, measured through any aperture or orifice." This miner's inch corresponds to the so-called "6-inch pressure," and is one-fortieth of a second-foot.

The determination of the quantity of water flowing past a certain section of a stream at a given time is termed a "discharge measurement." The quantity is the product of two factors—the mean velocity and the area of the cross section. The mean velocity is a function of surface slope, wetted perimeter, roughness of bed, and the channel conditions at, above, and below the gaging station. The area depends on the contour of the bed and the fluctuations of the surface. The two principal ways of measuring the velocity of a stream are by floats and current meters.

All measurements by the engineers of the Survey were made with the current meter, but as float measurements can readily be made by the prospector the method is described below.

The floats in common use are the surface, subsurface, and tube or rod floats. A corked bottle with a flag in the top and weighted at the bottom makes one of the most satisfactory surface floats, as it is affected but little by wind. In flood measurements good results can be obtained by observing the velocity of floating cakes of ice or débris. In all surface-float measurements the observed velocity must be multiplied by 0.85 to 0.90 to reduce it to the mean velocity. The subsurface and tube or rod floats are intended to give directly the mean velocity in the vertical. Tubes give excellent results when the channel conditions are good, as in canals.

In measuring velocity by a float, observation is made of the time taken by the float to pass over the "run"—a selected stretch of river or creek from 50 to 200 feet long. In each discharge measurement a large number of velocity determinations are made at different points

across the stream, and from these observations the mean velocity for the whole section is determined.

The area used in float measurements is the mean of the areas at the two ends of the run and at several intermediate sections.

PRECIPITATION.

Precipitation records for 1910 show that the rainfall at Fairbanks was about 15 per cent below the average from 1906 to 1910; at Fort Gibbon it was about 6 per cent below the average from 1904 to 1910; and at Fort Egbert it was about 2 per cent above the average from 1903 to 1910. At Rampart a precipitation of only 5.32 inches was recorded, which is lower than that of any other year since the beginning of records at that station in 1905 and only about one-half the average for the last six years.

A comparison of the records of 1910 with those of 1909 shows that at Fairbanks and Fort Gibbon there was a small decrease in precipitation during the last year, whereas at Fort Egbert there was a considerable increase. At Rampart the decrease was nearly 50 per cent from the precipitation of 1909.

Although there is a wide difference from month to month and from year to year in the rainfall at the several stations in the Yukon-Tanana region, the mean yearly precipitation at each station for the period covered by the records is uniformly close to the average of the means of all the stations. In other words, the records show no uniform difference in precipitation throughout this area.

The following table gives the monthly precipitation at all points in the Yukon-Tanana region where records have been kept subsequent to 1903. Such scattered records as were kept previous to 1903 have been compiled by Abbe.[1]

Monthly precipitation, in inches, at stations in Yukon-Tanana region, 1903–1910.

[Rainfall or melted snow is given in the first line; snowfall in the second line.]

Station.	Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Central	1906	0.56	0.06	0.05	0.47	0.86	4.91	4.82	1.85	0.52	0.70	0.80	0.35	15.95
		6.1	1.0	1.4	4.7	2.0					7.0	8.0	4.0	34.2
Do	1907	1.04	.42	2.57	.93	.57	2.21	1.40						
		10.0	4.0	4.0	8.0	1.5								
Circle	1906												.75	
													9.5	
Do	1907	1.02	.57	.28	.15	.29		1.36	2.79	1.73			.63	
		8.5	8	3.25									8.2	
Do	1908	1.23	.25	.76	1.45	.29	.20	.87	1.08	2.21	.40	.75	1.11	10.60
		9.2	2.5	6.8	8.0						3.0	8.5	11.2	51.2
Do	1909	.44	.47	.17	.75	.60	2.24	3.25	1.02					
		4.5	5.2	1.0	3.0									
Charity Creek	1908				.11	.27	1.33	2.80	2.33	2.28	.20			
											3.0			
Cleary	1907						.84	2.55	2.88	3.82				
Eagle Creek	1908								2.99					
Fairbanks	1904											1.10	2.00	
Do	1905	.92	.50	.05	.20				2.63	.86		1.20	.60	
		9.1	5.0	.5	2.0							12.0	5.1	

[1] Abbe, Cleveland, jr., Prof. Paper U. S. Geol. Survey No. 45, 1906, pp. 189–200.

Monthly precipitation, in inches, at stations in Yukon-Tanana region, 1903–1910—Con.

Station.	Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Fairbanks	1906	1.75	0.37	0.33	0.10	0.36	1.05	2.82	1.50	0.25	0.30	0.65	1.15	10.63
		17.5	3.7	3.3	1.0	.....	.....	.....	.....	.....	.6	6.5	11.5	44.1
Do.....	1907	3.30	.86	2.42	.03	.35	1.47	1.51	1.81	3.58	2.44	.35	.59	18.71
		33.0	8.6	24.2	.3	.....	.....	.....	.....	.....	24.4	3.5	5.9	99.9
Do.....	1908	.42	.21	1.10	.11	.52	.96	.75	.71	1.57	.47	.51	.65	7.96
		4.2	2.1	11.0	.8	.....	.....	.....	.....	.....	.....	.....	8.1	26.2
Do.....	1909	.90	.08	.05	.66	.38	1.64	1.90	1.73	.39	.80	.52	.80	9.85
Do.....	1910	.70	.14	.02	.36	.39	2.16	.46	1.09	1.91	.66	.50	.76	9.75
Faith Creek...	1907	.....	.....	.....	.....	.....	.....	1.87	3.00	2.97	.....	.....	.....	.....
Fort Egbert...	1903	.58	.81	.54	.12	1.38	.57	2.40	.97	2.97	.....	.....	.....	.....
Do.....	1905	.....	.....	.....	.....	.33	1.95	1.52	2.72	3.38	2.96	.93	.68	.....
Do.....	1906	.....	.14	2.19	.00	.54	.51	2.54	1.28	.01	1.71	.51	.07	.....
		.....	1.0	11.0	.....	.....	.....	.....	.....	.....	.46	8.5	1.0	.....
Do.....	1907	1.45	.21	0	.25	.40	1.89	1.48	1.98	1.45	1.12	.40	.31	10.94
		2.0	2.0	0	.15	.55	.....	.....	.....	.....	13.0	4.0	.....	.....
Do.....	1908	.12	.25	.75	.10	1.02	2.16	2.47	1.02	1.43	.18	.82	1.09	11.46
		3.0	2.5	7.5	1.0	.....	.....	.....	.....	.....	6.0	7.0	11.0	38.0
Do.....	1909	.16	.07	.11	.34	.28	2.35	1.77	.95	.88	.81	.30	.....	.....
		2.0	1.0	1.0	2.0	.....	.....	.....	.....	6.1	11.7	3.0	.....	.....
Do.....	1910	.83	.01	.53	.25	.28	1.05	2.28	2.63	2.98	.69	.25	.30	12.08
Fort Gibbon..	1903	.37	.73	1.14	.23	.16	.38	1.76	.....	.48	.22	.33	Tr.	.....
Do.....	1904	.08	.55	.35	.09	.22	.33	1.95	3.80	.35	.39	.07	.70	8.88
Do.....	1905	.37	.47	Tr.	.32	.84	1.50	4.90	3.02	.59	.50	1.10	.18	13.79
Do.....	1906	.65	.20	.30	Tr.	1.00	.....	.....	.....	.....	a.50	.99	.27	.....
		6.0	2.0	3.0	.....	.....	.....	.....	.....	.....	a5.0	9.9	2.7	.....
Do.....	1907	1.26	.....	.53	0	.30	.....	2.58	2.31	2.32	1.22	.03	.31	.....
		12.6	.....	5.0	0	.....	.....	.....	.....	4.0	12.0	1.5	.....	.....
Do.....	1908	.23	.26	.90	0	1.16	.....	.96	1.13	1.60	.45	.08	.60	.....
		4.0	6.0	17.0	0	.....	.....	.....	.....	2.25	6.0	.....	6.5	.....
Do.....	1909	.05	.10	.37	.39	1.51	.77	1.49	2.27	.90	.49	.46	.80	9.60
		.5	.5	.....	2.2	.....	.....	.....	.....	.....	4.8	4.6	8.0	20.6
Do.....	1910	1.23	.08	.60	.28	.69	.57	1.79	2.26	.74	.38	.....	.59	.....
Hot Springs...	1909	.....	.....	.....	.....	.....	.....	1.76	3.19	.25	.44	1.10	2.26	.....
		.....	.....	.....	.....	.....	.....	.....	.....	.....	4.4	11.0	22.6	.....
Do.....	1910	1.64	.03	.60	.20	.34	.76	b2.16	.....	1.32	.....	.....	.....	.....
		16.4	.3	6.0	2.0	3.4	.....	.....	.....	.....	.....	.....	.....	.....
Kechumstuk..	1904	.....	.....	.....	.....	1.80	.83	2.23	.94	.64	.30	.03	.23	.....
Do.....	1905	.90	.10	.05	.40	.20	1.58	.40	1.48	2.16	1.18	.36	.20	9.01
Do.....	1906	.36	.05	.06	.27	1.69	1.61	3.25	2.51	.51	.31	.29	.20	11.11
		4.0	.5	1.0	5.0	.....	.....	.....	.....	.....	4.3	.5	3.0	18.3
Do.....	1907	.12	.20	.27	Tr.	1.30	2.03	1.60	2.14	.49	.72	.40	.....	.....
		2.0	3.0	4.0	.....	12.0	.....	.....	.....	2.0	9.0	4.0	.....	.....
Do.....	1908	0	0	.41	.40	1.78	1.77	2.30	2.22	1.35	.....	.90	.20	.....
		0	0	5.0	4.0	.....	.....	.....	.....	.....	.....	9.0	2.0	.....
Do.....	1909	0	.30	.10	.20	0	3.66	3.39	.....	.....	.....	.....	.....	.....
		0	.5	1.0	.....	0	.....	.....	.....	.....	.....	.....	.....	.....
Miller House..	1909	.....	.....	.....	.....	.....	.....	2.98	1.26	.60	.93	.30	.30	.....
		.....	.....	.....	.....	.....	.....	.....	.....	4.0	8.0	3.0	3.0	.....
Do.....	1910	.....	.....	.....	.20	.....	1.94	2.37	.30	1.03	.....	.....	.....	.....
North Fork...	1905	.....	.....	.....	.....	.....	.....	.....	1.91	1.83	.....	.50	.20	.....
Do.....	1906	.70	.50	.10	.80	1.98	2.74	2.69	1.01	.72	.42	.55	.38	12.59
		7.0	5.0	1.0	8.0	.....	.....	.....	.....	.....	3.2	4.5	4.5	33.2
Do.....	1907	.69	.28	.27	Tr.	1.34	1.92	1.57	3.19	2.0	1.40	.20	.....	.....
		15.5	3.0	3.0	.....	4.0	.....	.....	.....	5.0	12.0	2.0	.....	.....
Do.....	1908	.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
		5.0	Tr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Poker Creek...	1907	.....	.....	.....	.....	.....	.....	.....	1.40	3.70	1.70	.25	1.09	.....
		.....	.....	.....	.....	.....	.....	.....	.....	.....	24.0	3.3	6.8	.....
Do.....	1908	.....	1.32	.....	.42	.58	1.80	2.02	.99	2.45	.75	.35	.61	.....
		.....	10.5	.....	5.0	.....	.....	.....	.....	4.5	6.9	4.4	12.6	.....
Do.....	1909	.68	.09	.03	.42	1.11	1.22	2.01	2.01	.....	.....	.....	.....	.....
		8.8	2.0	.5	8.0	2.5	.....	.....	.....	.....	.....	.....	.....	.....
Rampart.....	1905	.....	.....	.....	.....	.....	1.33	1.99	2.19	1.70	1.20	1.43	.33	.....
Do.....	1906	.63	.08	.17	.04	.40	.15	1.86	2.40	.59	.61	.95	.33	8.21
		7.2	2.0	1.8	.5	.....	.....	.....	.....	.....	.....	10.2	3.5	25.2
Do.....	1907	1.17	.44	1.17	.02	.44	1.64	2.29	3.38	2.52	.65	.55	1.26	15.53
		12.0	4.5	12.8	2.5	.....	.....	.....	.....	.....	.....	6.3	.....	.....
Do.....	1908	1.08	.52	.81	.58	.82	1.38	1.13	.46	1.56	.39	.73	1.14	10.60
		11.5	6.9	8.1	.....	.....	.....	.....	.....	.....	5.1	3.6	16.8	52.0
Do.....	1909	.09	.10	.37	.51	1.04	.85	2.01	1.41	.36	1.14	.35	1.99	10.22
		1.4	1.2	6.2	5.6	.....	.....	.....	.....	1.5	14.4	3.6	20.2	54.1
Do.....	1910	.84	.08	.36	.07	.20	.98	.71	.62	.43	.45	.26	.32	5.32
		11.1	.8	4.7	1.0	.....	.....	.....	.....	.....	6.0	3.5	5.0	32.1
Summit road house.....	1907	.....	.....	.....	.....	.....	.....	2.71	3.27	c3.33	.....	.....	.....	.....
Tanana Crossing.....	1904	.....	.....	.....	.....	.76	.....	.78	.89	1.06	.15	.10	.90	.....
Do.....	1905	.24	.08	.18	.00	.14	.....	.37	2.95	.....	1.40	.60	.....	.....
Do.....	1906	.30	.00	Tr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

a Oct. 7 to 31. b July 16 to 31. c Sept. 1 to 22.

Precipitation records for June to September, inclusive, at several points in the Yukon-Tanana region may be summarized as follows:

Summary of summer precipitation in Yukon-Tanana region.

Station.	Maximum.		Minimum.		Mean (inches).	Duration of records.	Precipitation for 1910 (inches).
	Inches.	Year.	Inches.	Year.			
Circle	7.64	1907	4.36	1908	6.38	1907–1909	.....
Fairbanks	8.37	1907	3.97	1908	5.97	1906–1910	6.22
Fort Egbert	9.57	1905	5.95	1909	7.06	1903, 1905–1910	8.94
Fort Gibbon	10.01	1905	4.98	1908	6.59	1903–1905, 1907–1910	5.36
Kechumstuk	7.88	1906	4.64	1904	6.41	1904–1908	.....
Rampart	9.83	1907	2.74	1910	5.66	1905–1910	2.74
Mean	.....	.....	.....	.....	6.35	.....	5.82

The uniformity of precipitation throughout the Yukon-Tanana region, as already noted, for yearly periods is also noticeable, though to a less extent, for the summer months. In the above table Fort Egbert has the highest average precipitation from June to September and is 12 per cent above the mean for all of the stations; Rampart has the lowest average precipitation and is 11 per cent below the mean for all the stations.

The table also shows that a total precipitation as high as 10.01 inches and as low as 2.74 inches has occurred during the mining season and it leads to the conclusion that the general scarcity of water for mining uses during 1910 throughout the Yukon-Tanana region (with the exception of the Rampart district) was not due to an unusually small amount of rainfall in the aggregate but rather to its distribution with respect to time and area. A study of the run-off from adjoining drainage basins during the last four years indicates that a wide difference in stream flow may be expected even though geologic and topographic conditions are apparently very similar. In order to arrive at any definite conclusions regarding areal distribution of the rainfall by a comparison of simultaneous records, it would be necessary to have a greater number of rain gages more systematically located. Such comparisons as can be made with the existing data, however, confirm the general opinion that the precipitation is distributed rather unevenly. This condition is often noticeable in the summer, when local showers visit one portion of the drainage basin and do not reach another portion.

HYDRAULIC DEVELOPMENT.

Because of many unfavorable factors, mining by the use of water under pressure has so far played a very small part in the recovery of placer gold in the Yukon-Tanana region. The relatively high elevations at which most of the mines are located and the uniformity in elevation of the sources of the streams make it extremely difficult to obtain a sufficient supply of water at an elevation that will give a working head at the mines. The low stream gradients which prevail in the interior make necessary some means of elevating the gravels, which in turn involves the use of larger quantities of water under a higher head than would be necessary if the slope of the bedrock underlying the gravels was equal to or greater than that required for the sluice boxes.

Notwithstanding the many difficulties which must be overcome in order to successfully utilize such means of extracting the gold, several small plants have already been installed and larger ones are under consideration.

The developments in the several districts during the season of 1910 are described in another section of this volume. (See pp. 153–172.)

WATER POWER.

The following tables have been prepared in order to summarize briefly the records of stream flow that have been gathered on streams in the Yukon-Tanana region which offer any possibility for water-power development.

In comparing the columns showing days of deficient discharge for several years on any stream, allowance should be made for the difference in the length of periods and also for the part of the season covered by the records. Ordinarily the longer the period the greater will be the number of days of deficient discharge for any given number of horsepower and the less favorable will be the comparison with some other year in which the records extend over a shorter length of time. Also the days of deficient discharge will be a greater percentage of the total number of days if the observations include only the low-water months.

The following tables give the horsepower (80 per cent efficiency) per foot of fall that may be developed at different rates of discharge and show the number of days on which the discharge and the corresponding horsepower were respectively less than the amounts given in the columns for "discharge" and "horsepower."

Estimated discharge and horsepower table for Chatanika River, Little Chena River, and Washington Creek for 1907–1910.

Discharge in second-feet.	Horsepower (80 per cent efficiency) per foot fall.	Days of deficient discharge.										
		Chatanika River below Faith Creek.			Chatanika River below Poker Creek.				Little Chena River and tributaries.[a]			Washington Creek below Aggie Creek.
		June 21 to Sept. 30, 1907.	July 13 to Sept. 30, 1908.	May 25 to Sept. 25, 1910.	June 20 to Oct. 14, 1907.	May 16 to Oct. 21, 1908.	May 9 to Oct. 5, 1909.	May 17 to Oct. 29, 1910.	July 22 to Sept. 10, 1907.	May 1 to Aug. 27, 1908.	July 1 to Aug. 31, 1910.	May 5 to Sept. 4, 1908.
22	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0
28	2.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
33	3	0	.....	.....	.....	.....	.....	.....	.....	.....	0	30
44	4	13	.....	0	.....	.....	.....	.....	.....	.....	18	51
55	5	16	.....	14	.....	.....	.....	.....	.....	0	35	61
66	6	29	.....	29	.....	.....	.....	.....	0	26	40	66
77	7	39	0	34	.....	.....	.....	.....	3	31	42	68
88	8	47	2	37	.....	.....	0	0	7	36	44	72
99	9	52	4	39	.....	.....	2	2	13	44	45	75
110	10	56	19	45	.....	.....	5	3	15	48	46	76
132	12	69	35	47	.....	.....	17	22	23	55	50	.....
154	14	73	57	54	0	.....	26	40	35	58	.....	.....
176	16	77	58	64	5	0	27	49	42	60	.....	.....
198	18	78	65	69	17	5	39	55	45	63	.....	.....
220	20	82	66	79	27	27	46	60	48	67	.....	.....

[a] The discharge of Little Chena River and tributaries includes the discharge of Little Chena River above Sorrels Creek, Elliott Creek, Sorrels Creek at mouth, and Fish Creek above Fairbanks Creek.

Estimated discharge and horsepower table for Fortymile and Seventymile rivers for 1910.

Discharge in second-feet.	Horsepower (80 per cent efficiency) per foot fall.	Days of deficient discharge.		Discharge in second-feet.	Horsepower (80 per cent efficiency) per foot fall.	Days of deficient discharge.	
		Fortymile River at "kink," July 9 to Sept. 23, 1910.	Seventymile River at falls, June 16 to Sept. 30, 1910.			Fortymile River at "kink," July 9 to Sept. 23, 1910.	Seventymile River at falls, June 16 to Sept. 30, 1910.
198	18	.....	0	275	25	2	18
209	19	.....	3	286	26	3	22
220	20	.....	4	297	27	7	26
231	21	.....	10	308	28	13	31
242	22	.....	10	330	30	15	33
253	23	0	11	385	35	20	49
264	24	2	16	440	40	30	57

WINTER RUN-OFF.

Measurements were made during April, 1910, to determine the winter flow of several streams in the Yukon-Tanana region. They were made by chopping holes through ice varying in thickness from 2 to 3½ feet, sounding, and measuring the velocity at each section by a current meter. The results are given in the following table:

Winter discharge measurements in Yukon-Tanana region in 1910.

Date.	Stream.	Drainage area.	Discharge.	Discharge. per square mile.
		Sq. miles.	*Sec.-feet.*	*Sec.-feet.*
Apr. 6....	Tanana River 3 miles below Chena	[a] 24,000	4,450	0.185
Apr. 8....	Chatanika River below Poker Creek	456	1.91	.0042
Apr. 17...	Salcha River at mouth	2,170	64.5	.0297

[a] This area was obtained from the topographic map of Alaska, scale 1:2,500,000, and is therefore only approximate.

It is reasonable to suppose that the discharge of streams in this section during April represents the minimum flow for the year if it is assumed that the supply is furnished by springs in the stream bed and underground drainage, which is no doubt the case.

The results obtained indicate that no general relation between the winter and summer flow can be deduced. Such a relation could hardly be expected, as the surface drainage is the principal factor regulating the summer flow, and this element is entirely lacking in the winter season, when all of the surface water is stored in the form of ice and snow.

It is interesting to note that the discharge per square mile of the streams measured is greater for large areas than for small, a relation which is ordinarily reversed during the summer months. There are not enough data at hand, however, to warrant the supposition that this relation exists generally.

FAIRBANKS DISTRICT.

DESCRIPTION.

The area known as the Fairbanks district extends about 60 miles to the north of Fairbanks and is from 40 to 50 miles wide. The greater part of the region lies in the lower Tanana basin, but a portion to the northwest drains directly to the Yukon. Generally speaking, the district embraces three divisions—a low, broad alluvial plain, a moderately high dissected plateau, and a mountain mass.

The low, broad plain forms the bottom lands of the lower Tanana Valley, which in this section is divided into several parts by the Tanana and its sloughlike channels. The main slough starts near the mouth of Salcha River, about 30 miles above Fairbanks, and diverts a portion of the Tanana waters. Its course is northward along the foothills of the plateau, and it receives Chena River about 9 miles above Fairbanks. The plain is swampy and is well covered with timber along the banks of the streams. In the vicinity of Fairbanks it has a general elevation of about 500 feet above sea level.

The plateau is drained by streams tributary to Tanana River which flow through rather broad, unsymmetrical valleys, chiefly extending in a northeast-southwest direction. Their bottom lands range in elevation from 500 to over 2,000 feet above sea level, and the dividing ridges are in general 1,000 to 3,000 feet above the stream beds. That portion of the plateau discussed in this report is drained principally by Little Chena and Chatanika rivers. The upper region of these drainage basins is crosscut by a zigzag range, which separates the Yukon from the Tanana drainage.

The mountain mass north of this plateau forms what might be termed the apex of the divide between the Tanana and the Yukon drainage basins; its highest points reach altitudes 4,000 to 5,000 feet above sea level and its corrugated slopes are drained principally by tributaries to Yukon River.

All drainage areas tributary to the Tanana are similar in character. The streams have little slope except near their source and flow over wide gravelly beds in shifting and tortuous courses, keeping to one side of the valley. Most of the channels have rather steep banks that form approaches to broad, level bottom lands which extend 1,000 to 4,000 feet or more before they meet the abrupt slopes of the dividing ridges. The drainage basins are 4 to 15 miles wide and are cut up by small tributary streams that flow through deep and narrow ravines.

A large portion of the area is covered with a thick turf, known as tundra, which is wet, spongy, and mossy and ranges in thickness from 6 inches to 2 feet. In some localities this is meadow-like, producing a rank growth of grass and a variety of beautiful wild flowers. Ground ice is found beneath this tundra in many places, particularly on the northern slopes, where the scanty soil supports little timber or other vegetation. The soil of the southern slopes is, for the most part, clay, underlain by a mica schist which affords suitable ground for ditch construction. When stripped of its mossy covering and exposed to the sun it thaws rapidly, so that the plow and scraper can be used to advantage.

Above altitudes of 2,000 to 2,200 feet practically the only vegetation is a scrubby, bushy growth which attains a height of 2 to 4 feet. In general the country below this altitude is timbered by spruce and birch, with scattered patches of tamarack and willow along the banks of the smaller streams. The timber increases in density and size toward the river bottoms, where the prevailing growth is spruce, much of which attains a diameter of 18 to 24 inches.

The Fairbanks mining district lies between Little Chena and Chatanika rivers. It embraces an area of about 500 square miles and extends 30 miles north of Fairbanks, which is situated on Chena Slough nearly 12 miles above its confluence with the Tanana. Most

of the producing creeks rise in a high rocky ridge, of which Pedro Dome, with an elevation of about 2,500 feet, is the center. At least half of the mines are located at an elevation of over 800 feet, and 25 per cent are over 1,000 feet above sea level.

GAGING STATIONS AND MEASURING POINTS.

The following list gives the locations at which gaging stations were maintained or discharge measurements made in 1910, in the Fairbanks district:

Gaging stations and measuring points in Fairbanks district, 1910.

Tanana River drainage basin:
- Chena River drainage basin:
  - Chena River above Little Chena River.
  - Little Chena River above Sorrels Creek.
  - Little Chena River below Fish Creek.
  - Elliott Creek above mouth.
  - Elliott Creek at mouth.
  - Sorrels Creek at mouth.
  - Fish Creek below Solo Creek.
  - Fish Creek at mouth.
  - Solo Creek at mouth.
  - Bear Creek at mouth.
  - Fairbanks Creek at mouth.
  - Miller Creek above Heim Creek.
  - Miller Creek at mouth.
  - Heim Creek at mouth.
- Chatanika River drainage basin:
  - Chatanika River below Faith Creek.
  - Chatanika River below Poker Creek.
  - McManus Creek at mouth.
  - Smith Creek above Pool Creek.
  - Pool Creek at mouth.
  - Charity Creek above Homestake Creek.
  - Homestake Creek at mouth.
  - Deep Creek at mouth.
  - Orphan Boy Creek at mouth.
  - First tributary below Sourdough Creek from right side at mouth.
  - Cripple Creek at mouth.
  - Cassiar Creek at mouth.
  - Flat Creek below Third Pup.
  - Flat Creek below First Pup.
  - Juniper Creek at mouth.
  - Kokomo Creek above Rusty Gold Creek.
  - Poker Creek at mouth.
  - Poker Creek ditch near outlet.
- Goldstream Creek drainage basin:
  - Gilmore Creek near mouth.
  - Pedro Creek near mouth.
  - Fox Creek near mouth.

CHENA RIVER DRAINAGE BASIN.

Chena River drains the area lying between Chatanika River on the north, Birch Creek on the east, and Salcha River on the south. It has a length of about 100 miles and flows slightly south of west to the lowlands of the Tanana Valley, where it empties its waters into Chena Slough. The principal tributaries are the West Fork and Little Chena River from the north and the South Fork from the south.

Little Chena River and its tributaries Sorrels and Fish creeks drain the southern slope of the divide between Chatanika and Chena rivers from the headwaters of Smith and Flat creeks to Pedro Dome, a distance of about 25 miles. The drainage basin is irregular in shape and crossed by a network of small, ramifying streams with precipitous slopes in their upper courses. The upper portion of the main stream is also steep, having a fall of 100 to 150 feet to the mile, but this slope decreases rather abruptly to about 18 feet to the mile in the vicinity of Elliott and Fish creeks.

Above Fish Creek the Little Chena flows through a rather broad, unsymmetrical valley, but below that stream it takes the center of a deep, rather narrow channel for about 10 miles, to Anaconda Creek, an important tributary which enters from the left. Below this point the valley gradually widens again until the stream reaches the lowlands tributary to Chena River, with which it unites 6 or 8 miles above the confluence of Chena Slough.

Monthly discharge of streams in Little Chena River drainage basin for 1907–1910.

Little Chena River above Sorrels Creek.

[Drainage area, 79 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Mean per square mile.	
1907.					
July 22–31	80	42	49.3	0.625	0.23
August	157	53	85.4	1.08	1.24
Sept. 1–10	95	66	86.2	1.09	.40
The period, 51 days	157	42	78.4	.993	1.87
1908.					
May 20–31	405	210	296	3.75	1.67
June	223	65	142	1.80	2.01
July	65	33	43.2	.547	.63
Aug. 1–26	79	28	41.1	.520	.49
The period, 99 days	405	28	103	1.30	4.80
1910.					
July	166	22	37.0	.468	.54
August	350	22	74.5	.943	1.09
The period, 62 days	350	22	55.8	.706	1.63

Monthly discharge of streams in Little Chena River drainage basin for 1907–1910—Con.

Little Chena River below Fish Creek.

[Drainage area, 228 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Mean per square mile.	
1908.					
May	1,670	265	832	3.65	4.21
June	651	161	284	1.25	1.40
July	161	64	94.9	.416	.48
Aug. 1–27	122	59	79.2	.347	.35
The period, 119 days	1,670	59	332	1.46	6.44
1910.					
July	232	38	67.3	.295	.34
August	460	36	109	.478	.55
The period, 62 days	460	36	88.2	.386	.89

Elliott Creek above mouth.

[Drainage area, 13.8 square miles.]

1907.					
July 22–31	9.0	2.5	5.94	0.430	0.16
August	23	5.8	11.0	.797	.92
Sept. 1–10	12.3	9.0	10.1	.724	.27
The period, 51 days	23	2.5	9.82	.711	1.35
1908.					
May 20–31	216	11	67.8	4.91	2.19
June	32	8.6	14.8	1.07	1.19
July	7.5	4.5	5.22	.378	.44
Aug. 1–26	4.6	4.4	4.48	.324	.31
The period, 99 days	216	4.4	15.5	1.12	4.13
1910.					
July	10.6	2.3	3.50	.254	.29
August	15.1	2.3	5.60	.405	.47
The period, 62 days	15.1	2.3	4.55	.330	.76

Sorrels Creek near mouth.

[Drainage area, 21 square miles.]

1907.					
July 22–31	14.7	6.0	10.5	0.500	0.19
August	32.1	10.3	18.2	.867	1.00
Sept. 1–10	19	14.7	16.0	.762	.28
The period, 51 days	32.1	6.0	16.3	.777	1.47
1908.					
May 20–31	131	36	73.0	3.48	1.55
June	72	27	42.8	2.04	2.28
July	38	11	19.9	.948	1.09
Aug. 1–26	18	10	12.5	.595	.58
The period, 99 days	131	10	31.3	1.49	5.50
1910.					
July	46	3.6	7.53	.359	.41
August	36	3.6	12.2	.581	.67
The period, 62 days	46	3.6	9.86	.470	1.08

Daily discharge, in second-feet, of Chena and Little Chena rivers and Elliott Creek for 1910.[a]

Day.	Chena River above Little Chena River (drainage area, 1,440 square miles).						Little Chena River above Elliott Creek (drainage area, 79 square miles).		Little Chena River below Fish Creek (drainage area, 228 square miles).		Elliott Creek above mouth (drainage area, 13.8 square miles).	
	May.	June.	July.	Aug.	Sept.	Oct.	July.	Aug.	July.	Aug.	July.	Aug.
1	.....	1,550	1,130	1,190	1,760	1,390	27	47	75	80	3.0	3.9
2	.....	1,870	1,200	1,470	1,620	1,350	27	37	70	67	3.0	3.6
3	.....	1,720	1,150	1,390	1,540	1,310	27	34	65	58	3.0	3.4
4	.....	1,400	971	1,180	1,660	1,130	27	32	60	56	2.9	3.1
5	.....	1,370	860	1,000	1,880	1,150	27	31	58	51	2.9	3.0
6	.....	1,330	811	925	2,340	1,120	27	28	56	48	2.8	2.8
7	.....	1,800	988	847	3,000	1,000	26	27	53	45	2.6	2.9
8	.....	1,550	998	784	2,800	874	25	26	50	44	2.6	2.6
9	.....	1,400	886	747	2,350	767	25	25	47	44	2.6	2.6
10	.....	1,440	798	687	2,090	759	25	25	48	42	2.8	2.6
11	.....	7,190	751	648	1,880	731	24	24	48	40	2.6	2.4
12	.....	8,850	711	641	1,760	699	24	24	48	39	3.0	2.3
13	.....	7,400	655	578	1,660	780	25	23	48	38	2.8	2.3
14	.....	4,860	655	578	1,630	870	24	22	47	36	2.6	2.3
15	.....	3,500	599	578	1,680	816	23	22	44	37	2.6	2.3
16	.....	2,650	602	578	2,580	727	22	24	40	39	2.5	2.6
17	4,550	2,440	606	578	3,260	679	22	27	38	50	2.4	3.8
18	3,880	2,060	582	613	3,260	719	22	350	38	194	2.3	14.6
19	3,290	1,700	544	1,590	3,280	727	23	272	41	460	2.5	14.8
20	3,180	1,420	538	4,700	2,910	691	22	194	40	256	2.4	15.1
21	3,480	1,320	518	4,350	2,360	634	23	126	44	194	3.3	10.8
22	3,690	1,240	495	3,670	2,050	571	33	98	64	162	4.2	8.4
23	2,980	1,210	495	2,640	1,960	550	89	80	111	142	5.5	6.9
24	2,640	1,180	557	2,330	1,900	550	166	82	232	142	10.6	8.9
25	3,210	1,150	1,010	2,040	1,870	550	85	100	145	172	6.5	8.4
26	3,630	1,090	1,390	2,180	1,750	550	55	118	108	176	5.2	7.8
27	2,430	1,020	1,370	2,540	1,690	550	41	102	85	162	4.2	7.1
28	1,660	1,040	1,200	2,290	1,620	550	37	91	70	145	3.6	6.5
29	1,420	982	1,020	2,360	1,560	.....	32	78	59	132	3.4	5.7
30	1,370	915	925	2,100	1,450	.....	37	72	64	122	3.6	5.2
31	1,330	.....	844	1,930	.....	.....	55	70	91	110	4.4	5.0
Mean	2,850	2,290	834	1,600	2,100	814	37.0	74.5	67.3	109	3.50	5.60
Mean per square mile	1.98	1.59	.579	1.11	1.46	.565	.468	.943	.295	.478	.254	.405
Run-off (depth in inches on drainage area)	1.10	1.77	.67	1.28	1.63	.59	.54	1.09	.34	.55	.29	.47

[a] All these discharges are based on well-defined rating curves.

Daily discharge, in second-feet, of Sorrels, Fish, and Miller creeks for 1910.

Day.	Sorrels Creek at mouth (drainage area, 21 square miles).a		Fish Creek below Solo Creek (drainage area, 21.5 square miles).b					Fish Creek at mouth (drainage area, 90.2 square miles).a		Miller Creek at mouth (drainage area, 16.7 square miles).c	
	July.	Aug.	June.	July.	Aug.	Sept.	Oct.	July.	Aug.	July.	Aug.
1	5.2	7.9	.....	7.1	7.0	13.3	9.2	24	18.0	3.5	3.3
2	5.1	6.8	.....	7.0	6.4	15.7	9.2	22	16.6	3.3	3.0
3	5.0	6.2	.....	7.0	5.9	13.3	.....	19.8	16.1	3.1	2.5
4	4.9	5.5	.....	6.9	5.5	28	.....	19.2	16.1	2.9	2.5
5	4.8	5.2	.....	6.8	5.1	35	.....	19.2	15.2	2.7	2.5
6	4.7	5.0	.....	6.7	5.1	22	.....	18.0	14.2	2.5	2.3
7	4.2	4.5	.....	6.3	5.1	13.3	.....	17.5	12.7	2.5	2.3
8	4.2	4.2	.....	6.7	5.5	12.2	.....	18.0	13.3	2.3	2.3
9	4.7	4.2	.....	6.1	5.2	12.2	.....	16.6	13.3	3.3	2.3
10	4.7	4.2	.....	6.1	5.0	9.2	.....	17.1	13.3	3.4	2.1
11	4.5	4.0	.....	6.1	5.0	9.1	.....	17.5	13.0	3.9	2.1
12	4.5	3.9	.....	6.7	4.8	9.0	.....	18.0	12.7	4.6	2.1
13	4.5	3.6	.....	6.3	5.0	9.0	.....	17.1	12.4	4.1	2.0
14	4.2	3.6	22	6.1	4.8	26	.....	17.1	12.4	3.4	2.0
15	4.2	3.6	17.5	5.7	5.0	44	.....	16.1	12.7	3.4	2.1
16	3.7	3.9	17.5	5.4	5.3	47	.....	15.6	13.8	3.0	2.3
17	3.6	5.0	17.5	5.7	13.3	50	.....	14.2	18.0	2.8	3.4
18	3.6	27	16.2	5.7	38	50	.....	13.8	59	2.8	10.4
19	4.0	32	9.5	6.4	38	35	.....	15.6	119	3.0	13.5
20	3.7	36	8.6	5.9	28	23	.....	16.1	68	3.0	10.0
21	4.2	27	10.4	10.0	26	21	.....	16.6	54	3.6	8.4
22	6.8	19.8	9.5	11.0	15.7	18.2	.....	25	42	4.1	6.7
23	14.1	15.0	9.5	12.0	13.3	14.5	.....	25	35	4.3	6.4
24	46	18.6	7.1	18.7	18.2	14.5	.....	42	38	5.2	6.4
25	21	21	7.1	20.0	23	14.5	.....	35	48	4.1	6.4
26	12.7	24	7.1	13.9	23	13.3	.....	25	44	3.4	6.4
27	10.0	20	8.6	13.9	15.7	11.2	.....	23	38	3.0	5.7
28	7.9	17.4	15.0	9.8	12.2	11.2	.....	19.2	36	2.8	5.7
29	6.8	15.0	10.4	8.9	12.2	10.2	.....	17.1	32	2.5	5.2
30	6.8	12.7	10.4	9.1	11.2	9.2	.....	17.1	29	3.4	4.6
31	9.1	12.0	.....	8.5	9.2	.....	.....	20	25	2.4	4.4
Mean	7.53	12.2	12.0	8.47	12.3	20.5	9.2	19.9	29.4	3.33	4.56
Mean per square mile	0.359	0.581	0.558	0.394	0.572	0.953	0.428	0.221	0.326	0.199	0.273
Run-off (depth in inches on drainage area)	0.41	0.67	0.35	0.45	0.66	1.96	0.03	0.25	0.38	0.23	0.31

a The discharges for Sorrels Creek at mouth and Fish Creek at mouth are based on well-defined rating curves.

b The channel of Fish Creek below Solo Creek shifted considerably during the period July 1 to August 9. The discharges for this interval were deduced by the indirect method for shifting channels.

c The bed of Miller Creek shifted to such an extent that three rating curves were needed to define the discharge, but sufficient measurements were made to render the results good.

Miscellaneous measurements in Chena River drainage basin in 1910.

Date.	Stream and locality.	Drainage area.	Discharge.	Discharge per square mile.
		Sq. miles.	*Sec.-ft.*	*Sec.-ft.*
July 10	Elliott Creek at mouth	41.5	8.7	0.21
July 31	....do	41.5	14.9	.36
July 7	Solo Creek at mouth	5.1	.89	.18
Aug. 9	....do	5.1	.76	.15
Aug. 22	....do	5.1	2.5	.49
July 7	Bear Creek at mouth	13.8	3.2	.23
Aug. 9	....do	13.8	2.6	.19
Aug. 23	....do	13.8	6.6	.48
July 7	Fairbanks Creek at mouth	18.9	3.8	.20
Aug. 9	....do	18.9	2.7	.14
Aug. 23	....do	18.9	7.4	.39
July 6	Miller Creek above Helm Creek	6.0	1.7	.28
Do	Helm Creek at mouth	4.0	.44	.11

CHATANIKA RIVER DRAINAGE BASIN.

Chatanika River is formed by the junction of Faith and McManus creeks, which drain the high ridge constituting the divide between the lower Tanana and Yukon basins. The river flows southwestward in a winding course through a long and rather narrow valley and unites with the Tolovana from the east about 30 miles above the confluence of that stream with the Tanana. Its course lies mostly to the west side of the valley, which is from half a mile to 7 miles wide and about 80 miles long. The drainage area of the river above its mouth is approximately 1,300 square miles.

Below the junction of Faith and McManus creeks the stream has a shifting, gravelly bottom. In low and medium stages it flows in a series of pools and rapids in a channel 75 to 200 feet wide; during the high-water period it may spread through several channels covering a width of 100 to 400 feet. This high-water channel is usually well defined by steep, alluvial banks ranging from 8 to 10 feet in height.

Below Poker Creek, a tributary from the right about 40 miles downstream from the junction of Faith and McManus creeks, the valley widens and the bottom lands become marshy and swampy. From the left the Chatanika receives Cleary, Eldorado, Dome, and Vault creeks and other less important streams from the mining district proper. Below these tributaries the valley narrows to a gorgelike channel, which it follows for about 10 miles; below this the dividing ridges disappear and the stream meanders through the low swampy grounds to the north of Tanana River. About 10 miles from its mouth Goldstream Creek, its largest tributary, joins it from the left.

The average elevation of the divides in the upper drainage area of the Chatanika is between 3,000 and 4,000 feet above sea level, and the altitude of the ridges bounding the valley on the east and west is about 2,000 feet. Below an altitude of 1,800 to 2,000 feet the slopes are heavily timbered.

The tributary streams from the right are short and precipitous, flowing through V-shaped valleys; those from the left have less precipitous courses and broader valleys and gradually lose themselves in the rather broad expanse of swamplike bottom lands.

Monthly discharge of Chatanika River for 1907–1910.

Chatanika River below Faith Creek.

[Drainage area, 132 square miles.]

Month	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Mean per square mile.	
1907.					
July 17–31	96	55	67.8	0.514	0.28
August	205	72	125	.947	1.09
September	1,990	119	342	2.59	2.89
The period, 76 days	1,990	55	178	1.31	4.26
1908.					
May 12–20	1,340	320	598	4.53	1.85
July 13–31	200	82	131	.992	.70
August	270	95	137	1.04	1.20
September	530	102	208	1.58	1.76
The period, 89 days	1,340	82	241	1.82	5.51
1910.					
May 25–31	683	320	473	3.58	.93
June	2,000	118	377	2.86	3.19
July	293	48	86.1	.652	.75
August	1,010	49	197	1.49	1.72
Sept. 1–25	430	141	233	1.77	1.65
The period, 124 days	2,000	48	235	1.78	8.24

Chatanika River below Poker Creek.

[Drainage area, 456 square miles.]

1907.					
June 20–30	250	192	228	0.500	0.20
July	283	167	211	.463	.53
August	1,160	216	428	.939	1.08
September	3,160	300	954	2.09	2.33
Oct. 1–14	860	232	506	1.11	.47
The period, 117 days	3,160	167	496	1.08	4.61
1908.					
May 16–31	4,120	1,730	2,730	5.99	3.56
June	2,280	283	984	2.16	2.41
July	942	204	332	.728	.84
August	455	192	284	.623	.72
September	1,160	266	461	1.01	1.12
Oct. 1–21	342	179	234	.513	.40
The period, 159 days	4,120	179	699	1.53	9.05
1909.					
May 9–31	3,620	474	1,870	4.10	3.51
June	1,220	152	416	.912	1.02
July	833	219	414	.910	1.05
August	1,740	179	530	1.16	1.34
September	219	130	151	.331	.37
Oct. 1–5	110	92	103	.226	.04
The period, 150 days	3,620	92	598	1.31	7.33
1910.					
May 17–31	1,900	600	944	2.07	1.16
June	3,260	248	686	1.50	1.67
July	822	104	196	.430	.50
August	2,720	95	481	1.05	1.21
September	1,410	298	553	1.21	1.35
Oct. 1–29	352	123	208	.456	.49
The period, 166 days	3,260	95	472	1.04	6.38

Daily discharge, in second-feet, of Chatanika River for 1910.

Day.	Chatanika River below Faith Creek[a] (drainage area, 132 square miles).					Chatanika River below Poker Creek[b] (drainage area, 456 square miles).					
	May.	June.	July.	Aug.	Sept.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	639	109	92	146	.....	1,020	269	144	361	280
2	.....	632	108	80	144	.....	1,020	262	145	350	263
3	.....	646	81	70	141	.....	892	214	144	351	263
4	.....	569	65	65	172	.....	861	174	140	376	263
5	.....	683	78	62	276	.....	682	193	134	674	257
6	.....	339	68	62	368	.....	600	173	125	967	160
7	.....	249	62	60	348	.....	600	165	124	561	138
8	.....	223	60	58	315	.....	500	154	125	502	134
9	.....	310	60	56	281	.....	456	144	126	471	134
10	.....	2,000	58	55	241	.....	1,770	132	123	397	132
11	.....	1,030	56	55	212	.....	3,260	126	122	358	123
12	.....	502	55	54	185	.....	1,610	130	117	330	126
13	.....	302	54	53	162	.....	1,460	136	114	315	175
14	.....	223	53	51	175	.....	1,020	128	111	570	257
15	.....	182	52	49	430	.....	456	111	95	1,410	352
16	.....	202	52	51	310	.....	372	110	98	1,120	326
17	.....	206	51	68	293	1,900	333	127	142	1,060	298
18	.....	144	51	477	268	1,500	298	104	455	917	277
19	.....	149	49	1,010	238	655	280	127	2,020	723	263
20	.....	157	48	907	216	600	263	133	2,720	625	239
21	.....	182	53	477	209	1,020	263	136	1,720	581	205
22	.....	339	99	245	202	988	248	112	923	569	200
23	.....	220	276	175	182	655	347	218	1,010	551	180
24	.....	202	293	202	154	800	329	544	624	445	180
25	683	178	127	260	146	1,350	294	822	503	376	180
26	329	172	102	276	.....	655	296	268	502	361	180
27	320	202	92	260	.....	655	293	212	499	357	168
28	348	157	75	238	.....	600	250	186	484	395	134
29	477	141	70	209	.....	600	252	170	480	298	134
30	542	118	106	175	.....	955	270	161	445	298	.....
31	610	.....	106	157	.....	1,160	.....	146	396	.....	.....
Mean	473	377	85.1	197	233	944	686	196	481	553	208
Mean per square mile	3.58	2.86	0.652	1.49	1.77	2.07	1.50	0.430	1.05	1.21	0.456
Run-off (depth in inches on drainage area)	0.93	3.19	0.75	1.72	1.65	1.16	1.67	0.50	1.21	1.35	0.49

[a] The discharges for Chatanika River below Faith Creek are based on a well-defined rating curve.

[b] The discharges of Chatanika River below Poker Creek are obtained by adding to the flow of the river the amount of water diverted by the Chatanika ditch. It was not possible to determine the discharge of the ditch accurately on account of shifting channel conditions, but as the flow was uniform and not a large percentage of the total it is thought that the values given are correct within 5 to 10 per cent. A fish dam built below the gage resulted in a backwater effect on the gage from July 3 to Aug. 13, when the dam was washed out.

Daily discharge, in second-feet, of McManus, Charity, and Homestake creeks for 1910.

Day.	McManus Creek at mouth[a] (drainage area, 80 square miles).					Charity Creek above Homestake Creek.[b]					Homestake Creek at mouth[b] (drainage area, 5.6 square miles).		
	May.	June.	July.	Aug.	Sept.	May.	June.	July.	Aug.	Sept.	May.	June.	July.
1	.....	242	23	42	64	.....	60	.....	4.0	14.8	.....	42	3.0
2	.....	183	23	34	59	.....	42	.....	3.8	13.3	.....	35	2.8
3	.....	175	24	32	59	.....	77	.....	3.6	11.8	.....	42	2.3
4	.....	152	23	26	80	.....	44	.....	3.4	14.8	.....	27	2.0
5	.....	225	42	23	160	.....	41	.....	3.2	13.5	.....	35	2.9
6	.....	156	36	23	199	.....	32	.....	3.2	12.0	.....	20	2.6
7	.....	104	23	23	187	.....	27	.....	3.2	10.0	.....	17.4	2.6
8	.....	85	23	21	168	.....	42	.....	3.2	9.0	.....	15.2	2.7
9	.....	120	22	19.0	141	.....	55	.....	3.2	8.0	.....	34	2.8
10	.....	769	21	18.0	120	.....	77	.....	3.2	7.0	.....	56	2.9
11	.....	486	21	17.0	104	.....	41	3.6	3.2	7.0	.....	36	2.9
12	.....	277	21	17.0	80	.....	.....	3.5	3.2	7.0	.....	17.4	.....
13	.....	152	21	15.0	69	.....	.....	3.4	3.2	7.0	.....	11.0	.....
14	.....	104	20	15.0	97	.....	.....	3.3	3.1	7.0	.....	8.4	.....
15	.....	85	19.0	13.0	282	.....	.....	3.2	3.0	7.0	.....	8.0	.....
16	.....	85	19.0	13.0	225	.....	.....	3.2	6.0	7.0	.....	11.0	.....
17	.....	69	18.0	16.0	187	.....	.....	3.2	9.0	7.0	.....	8.8	.....
18	.....	59	17.0	42	160	.....	.....	3.2	12.0	7.0	.....	7.4	.....
19	.....	57	17.0	277	138	.....	.....	3.2	17.9	7.0	.....	7.4	.....
20	.....	53	17.0	387	152	.....	.....	3.2	.....	7.0	.....	7.7	.....
21	.....	59	18.0	183	148	.....	.....	5.1	.....	7.0	.....	30	.....
22	.....	277	24	104	138	.....	.....	5.1	.....	7.0	.....	22	.....
23	.....	110	32	75	94	.....	.....	7.2	.....	7.0	.....	11.0	.....
24	.....	97	110	94	80	.....	.....	9.4	.....	7.0	.....	9.1	.....
25	359	91	55	130	72	.....	.....	8.0	.....	7.0	.....	5.3	.....
26	183	80	32	145	.....	22	.....	7.0	.....	7.0	16.3	4.6	.....
27	160	100	23	138	.....	22	.....	6.0	.....	7.0	49	4.2	.....
28	175	97	23	123	.....	32	.....	4.0	.....	7.0	39	4.2	.....
29	242	72	21	107	.....	44	.....	3.2	.....	.....	29	4.6	.....
30	255	30	51	85	.....	60	.....	5.1	.....	.....	42	4.6	.....
31	277	.....	59	69	.....	77	.....	4.3	.....	.....	50	.....	.....
Mean	236	155	29.0	75.0	131	42.8	48.9	4.64	4.98	8.58	37.6	18.2	2.08
Mean per square mile	2.95	1.94	0.362	0.938	1.64	.....	.....	.....	.....	.....	6.71	3.25	0.479
Run-off (depth in inches on drainage area)	[a]0.77	2.16	0.42	1.08	1.52	.....	.....	.....	.....	.....	1.50	3.63	0.20

[a] The discharges of McManus creek at mouth are based on a rating curve that is well defined between 50 and 400 second-feet.

[b] The discharges of Charity and Homestake creeks are only approximate on account of shifting channel conditions and insufficient measurements.

Miscellaneous measurements in the Chatanika River drainage basin in 1910.

Date.	Stream and locality.	Drainage area.	Discharge.	Discharge per square mile.
		Sq. miles.	*Sec.-feet.*	*Sec.-feet.*
July 10	Smith Creek above Pool Creek	17	5.4	0.32
Aug. 1	....do	17	7.3	.43
July 10	Pool Creek at mouth	14	4.8	.34
Aug. 1	....do	14	8.8	.63
July 10	Hope Creek at mouth	20.3	12.3	.61
July 31	....do	20.3	23	1.13
July 10	Deep Creek at mouth	10.8	2.4	.22
Do	Orphan Boy Creek at mouth	.....	1.4	.....
Aug. 2	First tributary below Sourdough Creek from right side at mouth.	5.1	1.5	.29
Do	Cripple Creek at mouth	12.3	2.8	.23
Do	Cassiar Creek at mouth	7.3	.72	.10
July 8	Flat Creek below Third Pup	7.0	1.1	.16
Aug. 2	Flat Creek below First Pup	16.9	3.6	.21
Aug. 3	Juniper Creek at mouth	8.7	2.0	.23
Do	Kokomo Creek above Rusty Gold Creek	26.1	3.8	.15
Aug. 5	Poker Creek at mouth	40.0	8.8	.22
Do	Poker Creek ditch near outlet	.....	5.3	.....

GOLDSTREAM CREEK DRAINAGE BASIN.

Goldstream Creek flows southwestward, in a narrow, winding course, between the drainage basin of Chatanika River on the right and the Little Chena and Tanana basins on the left, paralleling Chatanika River, which it enters from the east, and draining the central portion of the Fairbanks mining district. It is about 70 miles long and it drains an area of about 500 square miles. About 40 miles below its source it leaves the dividing ridges and for the remainder of its course to the Chatanika flows in a zigzag channel across the soft, mucky flats northwest of Tanana River. The stream bed is sandy and shifting, and the channel is deeply cut in the alluvial soil that forms the bottom lands.

The upper portion of the valley is drained by Pedro and Gilmore creeks, which join to form Goldstream Creek near Gilmore, about 12 miles north of Fairbanks. Fox Creek enters the main stream from the right about 2 miles below this junction.

Miscellaneous measurements in Goldstream Creek drainage basin in 1910.

Date.	Stream and locality.	Drainage area.	Discharge.	Discharge per square mile.
		Sq. miles.	*Sec.-feet.*	*Sec.-feet.*
June 25...	Gilmore Creek near mouth	10.7	6.5	0.61
Do....	Pedro Creek near mouth	14.3	6.1	.43
Aug. 10..	Fox Creek near mouth	7.4	.45	.061

SALCHAKET DISTRICT.

DESCRIPTION.

The Tanana precinct, which includes the Salchaket district, embraces the area drained by the Tanana and its tributaries from and including Salcha River to a point on Tanana River south of Lake Mansfield. The larger streams included in this area are Salcha, Goodpaster, Volkmar, and Healy rivers from the north and Delta River from the south.

TANANA RIVER DRAINAGE BASIN.

Tanana River rises near the international boundary line and flows in a general northwesterly direction for about 440 miles to its junction with Yukon River at Fort Gibbon.

The river in general follows the north side of the valley and is one maze of channels and islands. At McCartys, just above the mouth of Delta River, which is 95 miles from Fairbanks by the Government road, it flows in three channels except at extreme low water, when the middle one is dry. During the summer of 1909 the Alaska Road Commission installed ferries on the right and left channels and bridged the center one.

Tenderfoot and Banner creeks, which have been the largest gold producers in the district, are tributary to the Tanana about 75 miles northeast of Fairbanks, at a point about halfway between Goodpaster and Salcha rivers and from the same side.

Canyon Creek is a small stream which flows into the main stream from the north about 5 miles below Richardson.

Salcha River rises opposite the head of the South Fork of Birch Creek, about 25 miles from the Yukon. The average fall of the river from the Splits to the mouth is 10 feet to the mile, and from a point about 2 miles from the summit of the divide at the headwaters it averages 19 feet to the mile. At the mouth, which is 40 miles from Fairbanks, a ferry, post office, store, and roadhouse are located and good accommodations are at hand for the traveler. Redmond Creek enters the Salcha from the south about 15 miles above the mouth. Junction and Mosquito creeks, which join to form Redmond Creek, drain an area 6 to 8 miles north of the Tanana and parallel to it.

Little Salcha River, which is tributary to the Tanana from the east, enters the river at a point midway between the town of Salchaket and the Salcha telegraph station.

GAGING STATIONS AND MEASURING POINTS.

The following list gives the locations at which gaging stations were maintained or discharge measurements made in 1910 in the Salchaket district:

Gaging stations and measuring points in Salchaket district, 1910.

Tanana River drainage basin:
- Banner Creek at mouth.
- Canyon Creek near mouth.
- Salcha River at mouth.
  - Junction Creek above Moose Lake outlet.
- Little Salcha River at road crossing.

Monthly discharge of Salcha River at mouth for 1909–10.

[Drainage area, 2,170 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Mean per square mile.	
1909.					
July 4–31	9,130	1,630	3,830	1.76	1.83
August	7,460	1,750	3,690	1.70	1.96
September	1,730	1,350	1,460	.67	.75
The period, 89 days	9,130	1,350	2,980	1.37	4.54
1910.					
May 12–31	6,640	2,180	3,040	1.40	1.04
June	8,220	1,740	3,560	1.64	1.83
July	6,120	1,120	2,000	.920	1.06
Aug. 1–19	5,590	930	1,880	.866	.61
The period, 100 days	8,220	930	2,990	1.38	4.54

Daily discharge, in second-feet, of Banner Creek, Salcha River, and Junction Creek for 1910.

Day.	Banner Creek near mouth[a] (drainage area, 21.5 square miles).				Salcha River at mouth[b] (drainage area, 2,170 square miles).				Junction Creek above Moose Lake outlet[a] (drainage area, 23.6 square miles).			
	June.	July.	Aug.	Sept.	May.	June.	July.	Aug.	June.	July.	Aug.	Sept.
1	.....	6.1	19.3	7.2	.....	4,390	4,150	3,090	.....	5.3	30	4.6
2	.....	4.0	14.0	7.8	.....	4,050	3,360	2,690	.....	4.6	20	6.7
3	.....	3.1	12.2	8.8	.....	3,360	2,740	2,180	.....	4.3	14.5	6.2
4	.....	3.1	8.8	10.5	.....	3,090	2,040	1,640	.....	4.3	8.6	6.2
5	.....	7.8	7.2	11.2	.....	2,520	1,760	1,520	.....	5.8	5.8	25
6	.....	7.8	5.6	10.5	.....	2,060	2,260	1,310	.....	6.2	4.6	22
7	.....	7.8	5.6	10.5	.....	2,300	2,040	1,310	.....	5.8	4.3	14.5
8	.....	6.1	5.0	9.8	.....	1,740	1,580	1,310	8.6	4.6	4.3	10.2
9	.....	4.6	5.0	8.8	.....	3,000	1,310	1,260	7.2	4.6	4.3	8.6
10	.....	4.6	5.0	7.8	.....	6,010	1,160	1,120	209	4.3	4.0	8.6
11	.....	3.1	5.0	7.8	.....	7,480	1,120	1,120	193	3.8	4.0	7.9
12	.....	3.1	4.2	8.8	4,130	8,220	1,120	1,120	85	5.3	3.8	7.2
13	.....	3.1	4.2	12.2	5,780	7,060	1,420	1,120	41	4.6	3.8	7.2
14	.....	2.5	2.7	11.2	6,320	5,170	2,040	1,000	17.3	4.3	4.0	9.4
15	.....	2.5	2.7	11.2	6,180	3,360	1,970	930	11.2	3.8	4.3	12.2
16	.....	2.0	5.6	17.5	6,640	2,660	1,760	930	9.4	3.8	4.3	20
17	.....	2.5	5.0	15.7	5,000	3,270	1,420	2,480	7.9	3.8	4.6	34
18	.....	2.5	5.6	8.8	6,010	2,920	1,120	4,030	6.2	3.8	5.0	27
19	.....	2.5	9.6	12.2	4,650	2,580	1,120	5,590	5.8	3.8	7.2	14.5
20	4.6	2.5	12.9	10.5	4,350	2,480	1,310	.....	5.3	4.3	10.2	11.2
21	4.0	2.5	10.5	8.8	4,710	2,380	1,210	.....	5.0	3.0	12.2	11.2
22	4.0	3.1	9.6	10.5	3,750	2,270	1,120	.....	4.6	4.0	7.9	.....
23	4.0	11.1	8.8	12.2	3,180	2,550	1,120	.....	4.6	10.2	6.2	.....
24	4.0	11.1	8.8	14.0	3,910	2,830	2,830	.....	4.3	10.2	5.8	.....
25	4.0	4.6	8.2	15.7	5,480	2,830	6,120	.....	4.0	17.3	5.8	.....
26	13.5	3.1	8.2	15.0	5,550	2,830	2,740	.....	4.6	12.2	5.3	.....
27	7.8	3.1	7.8	14.0	4,050	3,950	2,410	.....	5.3	8.6	5.3	.....
28	7.8	2.5	7.8	15.7	3,750	3,180	2,110	.....	5.3	6.2	5.0	.....
29	7.8	3.1	7.2	14.0	3,750	3,000	1,520	.....	5.0	4.6	4.6	.....
30	7.8	23	7.2	12.2	2,180	2,740	1,520	.....	5.3	3.8	4.3	.....
31	.....	26	7.2	.....	4,750	.....	2,490	.....	.....	34	4.3	.....
Mean	6.30	5.63	7.63	11.4	3,040	3,560	2,000	1,880	3.11	6.62	7.04	13.1
Mean per square mile	0.293	0.262	0.355	0.530	1.40	1.64	0.920	0.866	1.32	0.281	0.298	0.555
Run-off (depth in inches on drainage area)	0.12	0.30	0.41	0.59	1.04	1.83	1.06	0.61	1.13	0.32	0.34	0.43

[a] The discharges at Banner and Junction creeks are only approximate on account of shifting channel conditions and insufficient measurements.

[b] The discharges of Salcha River at mouth are based on a rating curve that is well defined throughout.

Miscellaneous measurements in Salchaket district in 1910.

Date.	Stream and locality.	Drainage area.	Discharge.	Discharge per square mile.
		Sq. miles.	*Sec.-feet.*	*Sec.-feet.*
June 21	Canyon Creek near mouth	4.7	0.45	0.091
June 22	Little Salcha River at road crossing	70	28	.40
Aug. 15	....do	70	21	.30

CIRCLE DISTRICT.

DESCRIPTION.

The area north of the Yukon-Tanana divide between longitude 143° 40′ and 146° 50′ is known as the Birch Creek region of the Circle district. Generally speaking, it consists of two geographic divisions—a low, broad alluvial plain and a dissected plateau.

The northwestern portion of the low, broad plain forms the bottom lands of the Yukon Flats north of Crazy Mountains; the southeastern portion is an irregular area surrounded by a low ridge along the

Yukon, the Crazy Mountains, and the range of hills 20 to 40 miles farther south. This portion is cut by Birch and Crooked creeks; it is well timbered along these streams and contains large areas of meadow-like swamp land that furnish forage for both summer and winter use.

The plateau division, whose longer diameter trends east and west, lies between two distinct ridges—the eastern extensions of the White Mountains. The ridge to the south is high and barren and forms the main Yukon-Tanana divide; that to the north is lower, irregular, and barren, separates the upper tributaries of the Birch Creek basin from the lower, and is itself divided by the deep canyon-like gorge through which Birch Creek flows on its way to the Yukon.

At elevations of 2,000 feet or more above sea level the country is as a rule barren and rocky; below this altitude, especially in the flats where Birch and Crooked creeks join, considerable timber is found.

GAGING STATIONS AND MEASURING POINTS.

The following list gives the locations at which gaging stations were maintained or discharge measurements made in 1910 in the Circle district:

Gaging stations and measuring points in Circle district, 1910.

Birch Creek drainage basin:
- Birch Creek below Clums Fork.
- Birch Creek at Fourteenmile House.
- Fryingpan Creek below forks.
- Great Unknown Creek near mouth.
- Clums Fork at mouth.
- McLean Creek at mouth.
- North Fork of Birch Creek drainage basin:
  - North Fork of Birch Creek above Twelvemile Creek.
  - Ptarmigan Creek at mouth.
  - Golddust Creek 4½ miles above mouth.
  - Butte Creek at mouth.
  - Bear Creek at mouth.
  - Twelvemile Creek at mouth.
  - East Fork of Twelvemile Creek at mouth.
- Crooked Creek drainage basin:
  - Crooked Creek at Central House.
  - Porcupine Creek above ditch.
  - Porcupine Creek below Bonanza Creek.
  - Bonanza Creek above ditch intake.
  - Mammoth Creek at Miller House.
  - Mammoth Creek ditch at intake.
  - Independence Creek at mouth.
  - Miller Creek at claim "No. 6 above."
  - Miller Creek at mouth.
  - Boulder Creek at trail crossing.
  - Deadwood Creek above Switch Creek.
- Preacher Creek drainage basin:
  - Preacher Creek above Bachelor Creek.
  - Bachelor Creek below Costa Fork.
  - Bachelor Creek at mouth.
  - Costa Fork at mouth.

BIRCH CREEK DRAINAGE BASIN.

Birch Creek flows into Yukon River at a point almost exactly on the Arctic Circle and about 25 miles directly west of Fort Yukon. Its mouth is about 5 miles west of the confluence of Chandalar River with the Yukon.

The drainage comes almost entirely from the south and west through a complex system of watercourses, and in outline the basin is extremely unsymmetrical. The headwaters interlock with those of Little Chena and Chatanika rivers and flow east for about 60 miles to the junction of the South Fork, where the stream makes an abrupt turn northward. About 12 miles beyond this point it leaves the mountainous country and enters the lowlands of the Yukon, through which it sluggishly flows in a meandering channel for over 100 miles, roughly paralleling the Yukon at a distance varying from 10 to 20 miles.

The principal tributaries from the south and east are Clums Fork and the South Fork. From the north and west the North Fork and Harrison, Crooked, and Preacher creeks are the chief branches. The headwaters of the South Fork rise opposite those of Salcha and Charley rivers.

Monthly discharge of Birch Creek at Fourteenmile House for 1908 to 1910.

[Drainage area, 2,150 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Mean per square mile.	
1908.					
June 26–30	1,190	1,020	1,090	0.507	0.09
July	2,630	847	1,140	.530	.61
August	1,620	825	1,080	.502	.58
Sept. 1–29	6,070	900	2,150	1.00	1.08
The period, 96 days	6,070	825	1,423	1.48	2.36
1909.					
May 15–31	9,970	3,320	5,930	2.76	1.74
June	8,640	1,860	3,410	1.59	1.77
July	8,280	960	2,200	1.02	1.18
August	3,020	974	1,830	.851	.98
September	960	730	799	.372	.42
Oct. 1–2	792	792	792	.368	.03
The period, 141 days	9,970	730	2,510	1.17	6.12
1910.					
May 13–31	6,620	3,200	4,790	2.23	1.58
June	6,000	1,160	2,500	1.16	1.29
July	5,460	551	1,430	.665	.77
August	1,880	432	950	.442	.51
September	3,280	1,040	1,620	.753	.84
Oct. 1–6	1,140	1,080	1,090	.507	.11
The period, 147 days	6,620	432	2,010	.935	5.10

Daily discharge, in second-feet, of Birch Creek and Fryingpan Creek for 1910.

Day.	Birch Creek below Clums Fork [a] (drainage area, 600 square miles).				Birch Creek at Fourteenmile House [b] (drainage area, 2,150 square miles).						Fryingpan Creek below the forks [c] (drainage area, 15.9 square miles).		
	June.	July.	Aug.	Sept.	May.	June.	July.	Aug.	Sept.	Oct.	June.	July.	Aug.
1	.....	1,010	550	457	.....	4,070	3,690	1,680	1,040	1,140	.....	6.7	4.6
2	.....	604	424	508	.....	3,370	2,860	1,430	1,180	1,080	.....	5.8	3.8
3	.....	391	353	487	.....	2,900	2,070	1,200	1,430	1,080	.....	5.2	3.4
4	.....	296	272	497	.....	2,810	1,680	984	1,410	1,080	.....	4.9	3.2
5	.....	2,610	237	666	.....	2,420	1,610	756	1,380	1,080	.....	6.7	2.8
6	.....	1,370	220	881	.....	2,190	5,460	735	1,650	1,080	.....	6.5	2.6
7	.....	816	488	684	.....	1,840	3,060	648	1,680	.....	.....	5.4	2.4
8	518	539	175	593	.....	1,590	2,360	587	1,550	.....	5.4	4.9	2.4
9	566	409	164	539	.....	1,480	1,810	605	1,380	.....	11.2	4.8	2.3
10	2,030	349	147	497	.....	2,040	1,200	648	1,250	.....	17.0	4.5	2.3
11	2,610	296	147	477	.....	3,950	1,030	623	1,200	.....	15.2	5.7	2.3
12	2,660	284	142	438	.....	6,000	968	575	1,200	.....	13.6	6.2	2.2
13	1,420	307	125	396	3,810	4,920	900	527	1,120	.....	12.0	7.2	2.2
14	848	258	120	424	4,260	2,980	830	471	1,140	.....	10.5	5.8	2.1
15	604	207	123	1,810	5,240	2,260	760	460	1,180	.....	8.9	5.4	2.0
16	604	169	120	1,860	6,120	1,930	690	432	2,840	.....	7.3	4.9	2.2
17	529	161	125	1,700	6,070	1,680	620	432	3,280	.....	5.7	4.3	2.1
18	462	276	357	1,560	5,880	1,600	551	449	3,220	.....	5.4	6.5	.....
19	383	409	1,710	1,230	5,020	1,460	952	605	2,800	.....	5.1	5.8	.....
20	374	296	1,130	848	4,540	1,370	1,200	1,880	2,320	.....	4.9	5.3	.....
21	400	233	720	783	4,200	1,280	920	1,550	1,780	.....	7.2	5.4	.....
22	2,080	227	577	649	4,210	1,560	808	1,360	1,510	.....	8.8	5.8	.....
23	1,100	269	539	593	4,370	3,320	770	1,180	1,430	.....	6.8	6.0	.....
24	733	550	457	561	4,730	2,440	808	960	1,410	.....	6.0	6.3	.....
25	467	561	572	577	6,140	1,460	1,120	1,000	1,380	.....	5.3	5.7	.....
26	378	353	783	599	6,620	1,250	1,200	1,230	1,410	.....	5.1	2.7	.....
27	344	276	745	561	6,000	1,160	1,020	1,410	1,450	.....	5.1	2.6	.....
28	396	233	835	555	3,670	1,710	830	1,380	1,430	.....	5.3	2.5	.....
29	1,150	194	696	524	3,370	4,110	770	1,300	1,320	.....	5.2	2.5	.....
30	1,680	340	599	438	3,200	3,900	770	1,230	1,200	.....	9.0	11.0	.....
31	.....	752	524	.....	3,460	.....	936	1,120	.....	.....	.....	7.6	.....
Mean	971	485	448	748	4,790	2,500	1,430	950	1,620	1,090	8.09	5.50	2.64
Mean per square mile	1.62	0.808	0.747	1.25	2.23	1.16	0.665	0.442	0.753	0.507	0.509	0.346	0.166
Run-off (depth in inches on drainage area)	1.38	0.93	0.86	1.40	1.58	1.29	0.77	0.51	0.84	0.11	0.44	0.40	0.10

[a] The discharges of Birch Creek below Clums Fork are based on a well-defined rating curve below 700 second-feet. Above 700 second-feet the curve was extended by means of the area and velocity curves, and it is believed to represent the true relation of gage height to discharge up to 2,000 second-feet.

[b] The discharges of Birch Creek at Fourteenmile House are based on a rating curve well defined between 500 and 2,300 second-feet.

[c] The discharges of Fryingpan Creek are based on a rating curve well defined between 2.5 and 5.5 second feet.

Miscellaneous measurements in Birch Creek drainage basin in 1910.

Date.	Stream and locality.	Drainage area.	Discharge.	Discharge per square mile.
		Sq. miles.	*Sec.-ft.*	*Sec.-ft.*
July 26	Great Unknown Creek near mouth	41.2	16.7	0.40
July 25	Clums Fork at mouth	172	118	.69
Do	McLean Creek at mouth	15.4	3.0	.20

NORTH FORK OF BIRCH CREEK DRAINAGE BASIN.

Eagle and Ptarmigan creeks, whose headwaters are opposite those of Crooked Creek, join to form the North Fork of Birch Creek. Below the junction the North Fork takes a southwestward course for about 7 miles, to the mouth of Twelvemile Creek, where it turns abruptly to the south and follows that direction for about 8 miles. Here its waters unite with those of Harrington Fork to form Birch Creek proper, which flows east to its confluence with the South Fork, a distance of approximately 45 miles.

Beginning at the head, the main tributaries from the north are Fish, Bear, and Twelvemile creeks. From the south, in the same order, Golddust and Butte creeks are the only important streams.

Miscellaneous measurements in North Fork of Birch Creek drainage basin in 1910.

Date.	Stream and locality.	Drainage area.	Discharge.	Discharge per square mile.
		Sq. miles.	*Sec.-ft.*	*Sec.-ft.*
July 28	North Fork of Birch Creek above Twelvemile Creek.	87.1	55	0.63
Do	Ptarmigan Creek at mouth	19.0	15.0	.79
July 27	Golddust Creek 4½ miles above mouth	9.5	8.6	.90
July 28	Butte Creek at mouth	9.2	2.2	.24
Do	Bear Creek at mouth	12.4	6.7	.54
July 13	Twelvemile Creek at mouth	44.5	18.9	.42
July 28	do	44.5	14.6	.33
June 9	East Fork of Twelvemile Creek at mouth	22.9	60.0	2.62
July 13	do	22.9	7.4	.32
July 28	do	22.9	9.2	.40

CROOKED CREEK DRAINAGE BASIN.

Crooked Creek, which is formed by the junction of Mammoth and Porcupine creeks, meanders through a rather broad valley for about 30 miles and discharges its waters into Birch Creek about 10 miles above the Fourteenmile House. Not far below the Central House the valley loses its identity in the flats of Birch Creek.

Mastodon and Independence creeks unite to form Mammoth Creek, which receives Miller Creek about 2 miles below this junction from the west. The total length of that portion of the stream called Mammoth Creek is less than 4 miles.

Deadwood and Boulder creeks are tributaries from the south, below and above the Central House, respectively. They follow parallel courses about 3 miles apart, with a length of about 18 miles.

Albert Creek, the principal tributary from the north, drains the southern slope of the Crazy Mountains.

Daily discharge, in second-feet, of Crooked, Porcupine, and Bonanza creeks for 1910.

Day.	Crooked Creek at Central House[a] (drainage area, 161 square miles).				Porcupine Creek[b] above ditch intake (drainage area, 17.8 square miles).		Porcupine Creek below Bonanza Creek[c] (drainage area, 39.9 square miles).					Bonanza Creek[b] above ditch intake (drainage area, 7.9 square miles).	
	May.	June.	July.	Aug.	July.	Aug.	May.	June.	July.	Aug.	Sept.	June.	July.
1	.....	139	348	173	15	23	.....	100	38	42	9.7	38	19
2	.....	173	173	91	12	17.7	.....	82	29	31	9.7	32	15
3	.....	225	112	74	10	11.4	.....	102	23	25	9.5	36	10
4	.....	234	74	61	9.2	11.4	.....	85	19.7	22	9.3	30	9
5	.....	126	112	50	14	8.8	.....	73	48	17.8	10.9	29	32
6	.....	139	192	45	11	7.1	.....	64	38	10.9	12.4	23	25
7	.....	112	112	32	5.0	6.7	.....	49	27	12.6	12.4	20	14
8	.....	102	74	29	5.0	6.7	.....	43	23	11.6	11.8	20	12
9	.....	91	68	.....	3.7	5.4	.....	68	24	10.9	11.6	24	13
10	.....	300	61	.....	5.0	5.0	.....	131	19.9	10.5	11.3	42	10
11	.....	255	56	.....	4.5	4.5	.....	92	18.1	10.5	11.3	35	9
12	.....	212	50	.....	3.7	4.0	.....	77	17.2	9.7	11.3	30	8
13	.....	173	45	.....	3.7	4.0	.....	60	17.0	9.7	10.9	21	8
14	.....	139	40	.....	4.0	3.7	.....	46	15.6	9.3	11.3	16	7
15	173	112	36	.....	4.0	3.7	.....	44	10.9	9.0	38	15	5
16	173	102	33	.....	2.9	3.7	.....	55	10.1	9.3	40	19	5
17	112	112	30	.....	3.0	3.2	.....	46	10.5	9.3	32	16	5
18	102	102	255	.....	30	3.7	.....	36	71	9.5	26	12	30
19	91	82	173	.....	27	.....	.....	41	40	9.3	22	14	18
20	112	74	126	.....	17.7	.....	.....	57	28	9.9	17.6	19	13
21	126	112	102	.....	12.8	.....	.....	174	24	9.8	.....	28	11
22	139	348	112	.....	10.1	.....	.....	134	22	9.8	.....	30	10
23	112	255	126	.....	9.2	.....	.....	62	22	9.7	.....	27	11
24	139	173	112	.....	11.9	.....	.....	49	29	9.7	.....	24	16
25	212	112	91	.....	11.4	.....	.....	36	25	9.7	.....	15	12
26	112	91	74	.....	9.6	.....	.....	36	20	10.3	.....	18	9
27	74	91	61	.....	8.4	.....	.....	43	18.5	10.7	.....	18	8
28	50	173	50	.....	7.1	.....	.....	46	12.9	10.5	.....	20	8
29	173	397	40	.....	7.1	.....	51	76	16.2	10.1	.....	35	8
30	234	448	32	.....	62	.....	73	60	173	9.9	.....	30	27
31	300	.....	212	.....	41	.....	127	.....	74	9.7	.....	.....	30
Mean	143	173	103	69.4	12.3	7.43	83.7	68.9	31.1	12.9	16.4	24.5	13.5
Mean per square mile	0.888	1.07	0.640	0.431	0.691	0.417	2.10	1.73	0.779	0.323	0.411	3.10	1.71
Run-off (depth in inches on drainage area)	0.56	1.19	0.74	0.13	0.80	0.28	0.23	1.93	0.90	0.37	0.32	3.46	1.97

[a] Discharges of Crooked Creek at Central House are based on a rating curve well defined between 30 and 350 second-feet.

[b] The discharges of Porcupine and Bonanza creeks above ditch intakes are only approximate on account of shifting channel conditions.

[c] The discharges of Porcupine Creek below Bonanza Creek are based on a rating curve fairly well defined between 10 and 60 second-feet.

Daily discharge, in second-feet, of Mammoth and Deadwood creeks for 1910.

Day.	Mammoth Creek at Miller House[a] (drainage area, 37.1 square miles).			Deadwood Creek above Switch Creek[b] (drainage area, 21.3 square miles).				
	May.	June.	July.	May.	June.	July.	Aug.	Sept.
1	.....	80	47	.....	58	68	15.3	5.0
2	.....	95	25	.....	58	25	11.0	5.5
3	.....	77	21	.....	55	15.3	8.7	5.0
4	.....	66	30	.....	39	13.2	7.7	5.0
5	.....	66	90	.....	35	18.2	6.4	5.8
6	.....	62	54	.....	27	13.2	6.4	6.4
7	.....	54	33	.....	27	11.0	5.8	5.0
8	.....	54	25	.....	16.4	11.0	5.8	5.0
9	.....	63	17.5	.....	39	7.7	5.0	5.0
10	.....	79	17.5	.....	35	6.4	5.0	5.0
11	.....	64	17.5	.....	41	6.4	5.0	5.2
12	.....	63	17.5	.....	31	5.8	4.5	5.5
13	.....	58	17.5	.....	27	5.0	4.5	6.4
14	.....	49	21	.....	21	5.0	4.3	7.7
15	.....	48	17.5	.....	21	5.0	3.8	25
16	.....	53	14.8	.....	21	4.5	3.8	18.2
17	30	51	19.0	.....	21	8.4	3.8	18.2
18	47	30	11.8	.....	15.3	50	5.0	15.3
19	47	32	49	.....	15.3	25	5.5	13.2
20	35	49	37	.....	18.2	13.2	6.4	11.0
21	25	91	36	.....	21	13.2	5.7	.....
22	17.5	77	25	.....	25	13.2	5.0	.....
23	54	61	25	.....	21	8.7	4.5	.....
24	70	33	35	.....	15.3	8.4	3.8	.....
25	47	25	25	.....	13.2	7.2	5.5	.....
26	45	33	21	.....	11.0	6.4	5.0	.....
27	44	67	17.5	.....	11.0	5.5	6.4	.....
28	41	47	16.4	.....	98	5.5	5.0	.....
29	65	115	14.8	.....	102	9.4	5.8	.....
30	78	47	48	66	44	27	5.5	.....
31	93	.....	38	77	.....	19.9	5.0	.....
Mean	49.2	60.3	32.0	71.5	32.8	14.2	5.84	8.92
Mean per square mile	1.33	1.63	0.863	0.336	1.54	0.667	0.274	0.414
Run-off (depth in inches on drainage area)	0.74	1.82	0.99	0.25	1.72	0.77	0.32	0.31

[a] The discharges of Mammoth Creek below Miller House are obtained by adding to the discharge of the creek the amount of water diverted by the Mammoth Creek mining ditch. They are only approximate for certain periods during low water on account of insufficient data regarding the flow of the ditch.

[b] The discharges of Deadwood Creek above Switch Creek are based on a well-defined curve throughout.

Daily discharge, in second-feet, of Bonanza Creek ditch at intake for 1910.

Day.	May.	June.[a]	July.[a]	Aug.	Day.	May.	June.[a]	July.[a]	Aug.
1	.....	18.9	19.0	17.6	21	.....	18.9	10.5	.....
2	.....	19.2	13.0	13.1	22	.....	0	10.2	.....
3	.....	21	9.6	10.2	23	.....	0	10.5	.....
4	.....	23	8.4	8.4	24	.....	24	15.7	.....
5	.....	23	28	6.9	25	.....	14.4	11.9	.....
6	.....	20	20	.....	26	.....	15.7	8.7	.....
7	.....	17.3	13.3	.....	27	.....	17.3	8.0	.....
8	.....	16.0	11.5	.....	28	14.7	16.9	0	.....
9	.....	20	12.4	.....	29	14.4	26	0	.....
10	.....	22	9.4	.....	30	13.2	28	26	.....
11	.....	23	8.4	.....	31	15.0	.....	27	.....
12	.....	23	7.7	.....	Mean	14.3	17	11.6	11.2
13	.....	20	7.7	.....					
14	.....	16.0	6.6	.....					
15	.....	14.2	0	.....					
16	.....	18.6	0	.....					
17	.....	15.4	0	.....					
18	.....	12.1	27	.....					
19	.....	13.8	17.6	.....					
20	.....	18.9	12.2	.....					

[a] A change in the relation of gage height to discharge occurred during the period June 6 to July 15. Discharges for this interval were derived by the indirect method for shifting channels.

Miscellaneous measurements in Crooked Creek drainage basin in 1910.

Date.	Stream and locality.	Drainage area.	Discharge.	Discharge per square mile.
		Sq. miles.	*Sec.-ft.*	*Sec.-ft.*
May 29	Mammoth Creek ditch at intake	.....	33	.....
June 5	....do	.....	34	.....
July 14	Independence Creek at mouth	13.2	4.6	0.35
July 23	....do	13.2	6.8	.52
May 29	Miller Creek at claim "No. 6 above"	7.2	11.1	1.54
June 5	....do	7.2	17.4	2.42
July 14	....do	7.2	3	.42
Do	Miller Creek at mouth	10.5	3	.29
July 23	....do	10.5	6	.57
July 21	Boulder Creek at trail crossing	38.8	25	.64

PREACHER CREEK DRAINAGE BASIN.

Preacher Creek rises near the headwaters of Chatanika River and Beaver Creek and flows generally northeastward for about 65 miles, entering Birch Creek about 50 miles from the Yukon. It drains an area of 1,090 square miles, ranging in elevation from over 5,000 feet at the head to about 700 feet at the Birch Creek flats.

The main tributaries are the North Fork from the north and Loper and Rock creeks from the south. Bachelor Creek is a small but economically important branch from the south near the head.

Daily discharge in second-feet of Bachelor Creek below Costa Fork for 1910.[1]

[Drainage area, 11.4 square miles.]

July 11	6.6	July 21	7.6
July 12	6.4	July 25	8.1
July 13	5.9	July 26	7.6
July 14	5.3	July 27	7.4
July 15	5.2	July 28	7.1
July 16	5.0	July 29	7.0
July 17	5.6	July 30	8.5
July 18	8.5		
July 19	8.2	Mean	6.93
July 20	7.8		

Miscellaneous measurements in Preacher Creek drainage basin in 1910.

Date.	Stream and locality.	Drainage area.	Discharge.	Discharge per square mile.
		Sq. miles.	*Sec.-ft.*	*Sec.-ft.*
July 29	Preacher Creek above Bachelor Creek	94.7	45	0.48
Do	Bachelor Creek at mouth	26.4	7.6	.29
July 11	Costa Fork at mouth	4.5	2.1	.47

[1] The discharges are only approximate on account of shifting channel conditions.

FORTYMILE DISTRICT.

LOCATION OF AREA.

It seems desirable in a water-supply discussion to make the boundaries of the districts described coincide with those of certain drainage areas rather than to make them conform with those of precincts or recording districts, which may include partial drainage areas, as in the Fortymile and Eagle precincts. Therefore the Fortymile district will be considered to be the area drained by Fortymile River and its tributaries. This area has been topographically surveyed and is covered by three maps [1] separately published or in process of publication. The topography, geology, and gold placers of this area have been described by Prindle.[2]

GAGING STATIONS AND MEASURING POINTS.

The following list gives the locations at which gaging stations were maintained or discharge measurements made in 1910 in the Fortymile district:

Gaging stations and measuring points in Fortymile district, 1910.

Fortymile River drainage basin:
- Fortymile River at Steele Creek.
- King Solomon Creek at mouth.
- Liberty Creek at mouth.
- Dome Creek at trail crossing.
- Steele Creek at mouth.
- Canyon Creek below Squaw Gulch.
- Squaw Gulch at claim "No. 1 above."
- South Fork of Fortymile River drainage basin:
  - South Fork of Fortymile River below Franklin Creek.
  - Mosquito Fork below Kechumstuk Creek.
  - Kechumstuk Creek at mouth.
  - Gold Creek above Willow Creek.
  - Gold Creek 1 mile above mouth.
  - Walker Fork above Poker Creek.
  - Walker Fork above Twelvemile Creek.
  - Poker Creek one-half mile above mouth.
  - Davis Creek 1 mile above mouth.
  - Wade Creek at claim "No. 10 above."
  - Napoleon Creek at mouth.
  - Buckskin Creek above Fortyfive Pup.
  - Fortyfive Pup at claim No. 13.

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[1] Fortymile quadrangle: Maps can be obtained from the Director, U. S. Geol. Survey, Washington, D. C., at 5 cents per copy.

Circle quadrangle: Contained in Bulletin 295, which can be obtained from the Director, U. S. Geol. Survey; also in print as a separate publication, price 10 cents.

Area south of Circle and Fortymile quadrangles: In process of compilation.

[2] Prindle, L. M., The gold placers of the Fortymile, Birch Creek, and Fairbanks regions, Alaska: Bull. U. S. Geol. Survey No. 251, 1905.

Fortymile River drainage basin—Continued.
North Fork of Fortymile River drainage basin:
North Fork of Fortymile River above Slate Creek.
North Fork of Fortymile River above Middle Fork.
North Fork of Fortymile River at the "kink."
Slate Creek at mouth.
Champion Creek below Arkansas Creek.
Champion Creek above Bear Creek.
Champion Creek at mouth.
Bear Creek at mouth.
Middle Fork of Fortymile River at mouth.
Bullion Creek at mouth.
Hutchinson Creek below Confederate Creek.
Hutchinson Creek below Montana Creek.
Montana Creek at claim No. 7.

FORTYMILE RIVER DRAINAGE BASIN.

Fortymile River[1] is tributary to Yukon River at longitude 140° 30′ west and latitude 64° 30′ north, about 50 miles below Dawson, Yukon Territory, and approximately the same distance above the town of Eagle, Alaska. It has a drainage area of 6,350 square miles, about 4 per cent of which lies in Canadian territory. The basin is roughly symmetrical and the extreme north-south and east-west dimensions are each about 100 miles. The stream flow is predominantly from west to east. The main Fortymile River is formed by the North and South forks, which unite about 40 miles in an air line from the Yukon. On the north the tributaries interlock with those of Mission Creek and Seventymile and Charley rivers in high, rocky ridges of which Glacier Mountain is the most prominent feature. From the west Goodpaster, Volkmar, and Healy rivers take the adjoining drainage from mountains equally rugged. In the southeast portion the streams head in a country of relatively low relief and at a distance of only a few miles from Tanana River. Ladue Creek and Sixtymile River form the opposing drainage on the east and southeast, the moderately low dividing range being accentuated by several large dome-shaped mountains.

Near the international boundary the river flows through a narrow rock canyon from which it emerges into an open valley and takes a more moderate grade to its union with the Yukon. A prominent feature of the lower Fortymile is the well-defined bench which marks the elevation of an earlier valley floor. At Steele Creek the bench is about 500 feet above the water level. The plane of the present valley floor and that of the older one become coincident near the mouth of Kechumstuk Creek at an elevation of about 2,000 feet above sea level.

The principal tributaries below the forks are Steele, Canyon, Smith, and Moose creeks from the south and O'Brien Creek from the north.

[1] So called because its confluence with Yukon River is 40 miles below the old trading post of Fort Reliance.

Daily discharge, in second-feet, of Fortymile River at Steele Creek for 1910.[a]

[Drainage area, 5,890 square miles.]

Day.	June.	July.	Aug.	Sept.	Day.	June.	July.	Aug.	Sept.
1	.....	7,980	575	896	21	.....	880	1,620	1,760
2	.....	5,630	584	880	22	.....	730	1,560	1,530
3	.....	4,260	580	880	23	.....	737	1,320	1,300
4	.....	2,920	567	1,230	24	.....	758	1,210	.....
5	.....	2,360	543	1,450	25	.....	772	1,190	.....
6	.....	2,660	521	1,450	26	.....	880	1,280	.....
7	.....	2,160	507	1,540	27	.....	786	1,250	.....
8	.....	1,720	535	1,470	28	13,300	706	1,210	.....
9	.....	1,270	7,470	1,270	29	13,900	682	1,180	.....
10	.....	2,240	7,240	1,150	30	11,000	630	1,180	.....
11	.....	2,130	4,900	1,130	31	.....	580	1,020	.....
12	.....	2,060	3,590	1,130	Mean	12,700	1,870	1,780	1,600
13	.....	2,090	2,660	1,080	Mean per square mile	2.16	0.317	0.302	0.272
14	.....	2,280	2,130	1,030	Run-off (depth in inches on drainage area)	0.24	0.36	0.35	0.23
15	.....	1,790	1,670	1,050					
16	.....	1,660	1,360	2,720					
17	.....	1,500	1,280	3,080					
18	.....	1,210	1,490	3,440					
19	.....	1,030	1,450	2,890					
20	.....	952	1,450	2,440					

[a] The rating curve for this station is fairly well defined for all stages.

Daily discharge, in second-feet, of Steele, Canyon, and Squaw creeks for 1910.

Day.	Steele Creek at mouth[a] (drainage area, 12.5 square miles).				Canyon Creek below Squaw Gulch[a] (drainage area, 58.4 square miles).			Squaw Gulch at claim "No. 1 above"[b] (drainage area, 24.4 square miles).		
	June.	July.	Aug.	Sept.	July.	Aug.	Sept.	July.	Aug.	Sept.
1	.....	4.6	0.4	3.0	.....	9.6	18.0	.....	1.2	5.9
2	.....	3.2	.3	3.0	11.7	6.8	18.0	.....	1.0	5.9
3	.....	2.1	.3	3.0	10.3	6.8	18.0	3.8	1.2	8.9
4	.....	1.5	.2	3.0	10.3	6.8	39	4.5	1.0	6.9
5	.....	1.4	.1	3.4	12.6	6.8	39	3.8	1.0	5.9
6	.....	2.8	.1	10.5	34	5.7	15.0	10.5	.8	10.5
7	.....	2.1	.2	8.0	72	6.8	15.0	8.9	.8	11.8
8	.....	1.7	5.6	5.6	12.6	72	39	5.9	27	10.5
9	.....	1.1	254	5.0	12.6	348	39	4.5	143	10.5
10	.....	.9	26	5.0	12.6	288	50	3.8	43	14.8
11	.....	.9	10.5	4.0	12.6	181	57	5.9	27	16.8
12	.....	.8	6.2	4.0	34	137	72	7.8	10.5	21
13	.....	5.6	4.2	4.0	97	116	72	70	7.8	27
14	.....	5.0	3.0	4.0	72	80	72	52	5.9	52
15	.....	3.0	2.2	4.0	51	72	80	31	75	66
16	.....	2.1	4.0	8.0	29	62	88	15.0	27	79
17	.....	1.5	4.0	14.6	15.0	50	88	8.9	6.9	60
18	.....	1.2	4.6	12.5	18.0	39	97	5.9	10.5	27
19	.....	1.0	5.0	10.5	12.6	12.6	116	3.8	13.4	32
20	.....	.9	4.0	8.0	8.6	18.0	.....	3.1	8.9	30
21	.....	.8	3.4	6.5	12.6	15.0	.....	3.1	5.9	29
22	.....	.8	2.7	.....	15.0	18.0	.....	2.6	3.1	28
23	.....	.8	2.6	.....	18.0	25	.....	2.6	5.9	27
24	.....	.7	2.8	.....	10.3	29	.....	2.2	8.9	27
25	.....	.6	3.4	.....	10.3	34	.....	2.2	11.8	27
26	.....	.5	8.0	.....	10.3	39	.....	1.8	11.8	13.4
27	.....	.4	5.0	.....	12.6	44	.....	1.5	10.5	10.5
28	36	.4	6.5	.....	8.6	15.0	.....	1.2	10.5	10.5
29	16.2	.4	5.0	.....	6.8	8.6	.....	1.0	4.5	.....
30	8.0	.3	3.4	.....	8.6	12.6	.....	1.0	6.9	.....
31	.....	.2	3.0	.....	8.6	18.0	.....	1.0	5.9	.....
Mean	20.1	1.59	12.3	6.17	22.0	57.5	54.3	9.29	16.1	24.1
Mean per square mile	1.61	0.127	0.984	0.494	0.377	0.984	0.930	0.381	0.660	0.988
Run-off (depth in inches on drainage area)	0.18	0.15	1.13	0.38	0.42	1.13	0.66	0.41	0.76	1.03

[a] The discharges for these stations are well defined below 40 second-feet.
[b] The discharges for this station are fairly well defined below 15 second-feet.

Miscellaneous measurements in Fortymile River drainage basin in 1910.

Date.	Stream and locality.	Drainage area.	Discharge.	Discharge per square mile.
		Sq. miles.	*Sec.-ft.*	*Sec.-ft.*
June 27	King Solomon Creek at mouth	54.2	17.3	0.32
July 30	....do	54.2	5.7	.11
June 27	Liberty Creek at mouth	43.1	19.4	.45
July 30	....do	43.1	4.9	.11
June 28	Dome Creek at trail crossing	24.9	14.8	.59

SOUTH FORK OF FORTYMILE RIVER DRAINAGE BASIN.

The South Fork is formed by the junction of Dennison and Mosquito forks, which unite about 25 miles above its mouth. Below the forks the river flows due east for about 4 miles to a point just below the mouth of Atwater Creek, where it makes a right-angle turn and flows northward to its confluence with the North Fork.

The principal tributaries from the west in sequence upstream are Butte, Buckskin, and Franklin creeks, and from the east Uhler and Napoleon creeks, Walker Fork, and Atwater Creek are the main drainage channels.

Walker Fork, which is the largest tributary of the South Fork, joins the main stream about 16 miles from its mouth, a short distance above Napoleon Creek. It rises in Canadian territory about 2 miles beyond the boundary, flows westward for about 35 miles, and drains a total area of 414 square miles. Its principal tributaries from the north are Wade, Twelvemile, Davis, and Poker creeks. From the south, Liberty Fork and Cherry Creek are the most important affluents.

Mosquito Fork, the left branch of the South Fork, heads at an elevation of 3,000 to 4,000 feet in a ridge paralleling Tanana River and about 20 miles from that stream. The general direction of flow is northeast for about 75 miles, and the drainage area comprises 1,120 square miles. Chicken Creek is the first tributary from the north, and although of small drainage area it is economically important as a gold producer. Gold Creek joins from the north about 12 miles above Dennison Fork, and Kechumstuk Creek enters from the same side about 8 miles farther upstream. Near the mouth of Kechumstuk Creek, at an elevation of about 2,000 feet, an abrupt decrease in stream gradient is noticeable, and the valley above this place widens and becomes swampy. The valley floor narrows again about 8 miles above, at a point where a spur from the south approaches the stream. This spur marks the lower end of the flat swampy area known as Mosquito Flats, which constitutes a large portion of the upper drainage area of Mosquito Fork. These flats extend along the stream for about 20 miles and at some places are 12 to 14

miles wide. They are a tangle of lakes and sloughs, and it is said that during a wet season they are practically covered with water.

Dennison Fork has its source in a country similar to that of Mosquito Fork, and the ridge separating its drainage from that of Tanana River parallels the Tanana at a distance varying from 4 to 10 miles. The flat basin at the head is not so pronounced as that of Mosquito Fork, but the valleys are broad and swampy, with very gentle slopes. The drainage area is 1,540 square miles, about equally divided between two forks which unite to form the main stream about 12 miles above its mouth.

Daily discharge, in second-feet, of South Fork, Mosquito Fork, and Kechumstuk Creek for 1910.[a]

Day.	South Fork of Fortymile River at Franklin Creek (drainage area, 3,180 square miles).			Mosquito Fork below Kechumstuk Creek (drainage area, 824 square miles).				Kechumstuk Creek at mouth (drainage area, 189 square miles).			
	July.	Aug.	Sept.	July.	Aug.	Sept.	Oct.	July.	Aug.	Sept.	Oct.
1	.....	179	420	.....	52	65	49	.....	13.0	14.8	14.8
2	.....	179	420	.....	49	63	41	.....	13.0	14.8	13.0
3	.....	166	468	.....	47	58	37	.....	12.7	13.9	11.8
4	.....	153	468	.....	43	56	.....	.....	12.4	13.5	.....
5	.....	153	420	.....	43	56	.....	.....	11.8	15.8	.....
6	.....	134	420	.....	41	58	.....	.....	11.1	17.1	.....
7	.....	134	420	325	40	58	.....	80	10.5	17.6	.....
8	.....	179	420	286	45	56	.....	69	12.7	17.6	.....
9	735	5,120	420	227	234	56	.....	52	178	16.7	.....
10	683	4,060	420	202	193	56	.....	42	132	16.7	.....
11	631	2,530	420	175	179	56	.....	39	87	15.8	.....
12	540	1,900	420	175	186	53	.....	32	49	15.8	.....
13	709	1,420	420	197	149	52	.....	97	39	14.8	.....
14	870	968	468	193	130	53	.....	92	32	15.8	.....
15	842	787	468	197	102	58	.....	65	24	18.3	.....
16	870	709	516	238	89	65	.....	49	21	25	.....
17	912	761	516	193	83	72	.....	39	24	30	.....
18	870	842	631	162	80	77	.....	32	24	33	.....
19	420	842	631	140	74	80	.....	26	22	32	.....
20	372	709	631	119	77	74	.....	24	24	25	.....
21	324	631	631	104	79	66	.....	22	24	22	.....
22	324	631	566	99	109	62	.....	24	22	16.7	.....
23	324	631	566	94	106	50	.....	24	17.6	16.7	.....
24	324	631	516	86	95	53	.....	24	17.1	16.7	.....
25	324	631	516	83	94	53	.....	22	17.1	16.7	.....
26	282	566	516	83	86	49	.....	19.1	16.7	15.8	.....
27	237	566	516	83	80	47	.....	17.1	15.8	14.8	.....
28	237	566	468	80	74	46	.....	15.8	14.8	14.8	.....
29	237	516	468	70	69	38	.....	14.8	15.8	11.8	.....
30	237	468	420	63	66	37	.....	13.9	14.8	12.4	.....
31	237	468	.....	57	63	.....	.....	13.0	14.8	.....	.....
Mean	502	911	487	149	92.2	57.4	42.3	37.9	30.4	18.1	13.2
Mean per square mile	0.158	0.286	0.153	0.181	0.111	0.070	0.051	0.201	0.161	0.096	0.070
Run-off (depth in inches on drainage area)	0.13	0.33	0.17	0.17	0.13	0.08	0.006	0.19	0.18	0.11	0.008

[a] The discharges at these stations are fairly well defined for all stages.

Daily discharge, in second-feet, of Walker Fork, Wade Creek, and Forty-five Pup for 1910.

Day.	Walker Fork above Twelve-mile Creek [a] (drainage area, 70.2 square miles).		Wade Creek at claim "No. 10 above" [b] (drainage area, 23.1 square miles).			Forty-five Pup at claim No. 13 [c] (drainage area, 9.1 square miles).		
	July.	Aug.	July.	Aug.	Sept.	July.	Aug.	Sept.
1	.....	30	.....	2.0	11.0	.....	0.7	1.7
2	.....	15.0	.....	1.1	13.4	.....	.6	2.3
3	33	11.3	.....	1.1	13.4	.....	.6	2.3
4	30	11.3	2.1	1.1	13.4	.....	.6	1.7
5	27	10.0	5.5	1.7	12.2	.....	.6	1.3
6	51	8.7	8.8	1.1	16.4	.....	.6	1.3
7	37	10	7.4	1.7	13.4	.....	.6	1.3
8	26	54	6.0	31	11.0	.....	13.2	1.3
9	23	242	4.5	125	11.0	.....	63	1.3
10	26	114	3.0	90	13.4	.....	16.6	1.3
11	30	61	6.5	11.0	13.4	1.4	9.1	1.3
12	26	41	10.0	16.4	12.2	2.2	5.4	1.3
13	46	33	13.0	11.0	11.0	3.1	4.5	.....
14	33	26	16.4	12.2	16.4	2.4	3.7	.....
15	41	20	5.0	8.8	16.4	1.9	2.9	.....
16	26	25	10.0	27	13.4	1.4	3.7	.....
17	23	30	7.5	23	19.5	1.9	2.9	.....
18	23	30	9.0	19.5	16.4	1.4	2.3	.....
19	26	26	5.2	19.5	16.4	1.0	2.3	.....
20	15.0	26	1.5	13.4	13.4	.7	2.3	.....
21	20	26	4.0	13.4	11.0	.8	2.3	.....
22	30	26	6.5	16.4	11.0	2.3	1.7	.....
23	33	30	9.0	8.8	13.4	1.7	1.3	.....
24	37	30	7.0	13.4	11.0	1.3	1.7	.....
25	26	26	5.2	40	8.8	1.0	1.7	.....
26	20	26	3.5	23	16.4	.8	1.3	.....
27	15.0	.....	1.7	27	13.4	.8	2.3	.....
28	13.2	.....	2.5	23	13.4	.7	1.7	.....
29	26	.....	3.2	13.4	8.8	.7	1.3	.....
30	30	.....	4.0	13.4	8.8	.6	1.3	.....
31	30	.....	3.0	11.0	.....	.6	1.7	.....
Mean	28.4	38.0	6.11	20.0	13.1	1.37	4.98	1.53
Mean per square mile	0.405	0.541	0.264	0.866	0.567	0.151	0.547	0.168
Run-off (depth in inches on drainage area)	0.44	0.52	0.27	1.00	0.63	0.12	0.63	0.07

[a] The rating curve for this station is fairly well defined below 50 second-feet discharge; above that point it is only approximate.

[b] Discharges at this station from July 7 to 13 and 14 to 26 and July 28 to Aug. 1 were determined from comparative hydrographs and are only approximate. The rating curve is fairly well defined below 25 second-feet discharge.

[c] The discharges given for this station below 20 second-feet are probably correct within 10 per cent.

Daily discharge, in second-feet, of Buckskin Creek above Forty-five Pup for 1910.

[Drainage area, 33 square miles.]

July 11	4.3	Sept. 1	5.3
July 13	4.8	Sept. 4	4.3
July 14	4.3	Sept. 5	3.9
Aug. 4	3.3	Sept. 13	3.9
Aug. 5	2.9		
Aug. 11	12.4	Mean	4.88
Aug. 21	4.3		

Miscellaneous measurements in South Fork of Fortymile River drainage basin in 1910.

Date.	Stream and locality.	Drainage area.	Discharge.	Discharge per square mile.
		Sq. miles.	*Sec.-ft.*	*Sec.-ft.*
Aug. 7	Gold Creek above Willow Creek	57.7	2.0	0.03
Aug. 12	Gold Creek 1 mile above mouth	112	21	.19
July 2	Walker Fork above Poker Creek	7.4	5.7	.77
Do	Poker Creek one-half mile above mouth	3.1	1.3	.42
Do	Davis Creek 1 mile above mouth	1.5	1.5	1.00
July 5	Napoleon Creek at mouth	13.3	1.1	.08

NORTH FORK OF FORTYMILE RIVER DRAINAGE BASIN.

The North Fork drains a large area north and west of the main stream, rising in irregular ridges to heights of 3,000 to 6,000 feet. Near the headwaters the valleys are broad with gentle slopes, but nearer the mouth they become canyon-like, with prominent benches, which are merely continuations of those already mentioned in connection with Fortymile River. The drainage area is 2,120 square miles.

The principal tributaries from head to mouth are Comet and Champion creeks from the east, and Slate Creek, Middle Fork, Bullion and Hutchinson creeks from the west. The drainage area of the Middle Fork is 1,110 square miles, which is 52 per cent of the total drainage of the North Fork. Its headwaters drain a flat basin-like country smaller than but similar to that of Mosquito and Dennison forks.

About 3 miles below the mouth of Hutchinson Creek the river originally followed a large meander locally known as the "kink." Although the distance around was 2¾ miles, the two channels at the neck of the meander were separated by a sharp rock ridge only about 100 feet high and about the same distance in width at the water level. Several years ago a channel was blasted through the rock ridge to divert the water and thus drain the meander for mining purposes. A fall of about 17 feet is now concentrated in a horizontal distance of only a little over 100 feet, which gives possibilities for development of considerable water power. (See horsepower table, p. 180.)

Daily discharge, in second-feet, of North Fork and Hutchinson and Montana creeks for 1910.

Day.	North Fork of Fortymile River above Middle Fork [a] (drainage area, 724 square miles).				North Fork of Fortymile River at "kink" [b] (drainage area, 2,010 square miles).			Hutchinson Creek below Montana Creek [c] (drainage area, 29.0 square miles).		Montana Creek at claim No. 7 (drainage area, 5.9 square miles).		
	July.	Aug.	Sept.	Oct.	July.	Aug.	Sept.	July.	Aug.	July.	Aug.	Sept.
1	.....	162	135	189	.....	293	352	.....	4.5	.....	0.5	1.1
2	.....	162	204	162	.....	300	340	.....	4.1	.....	.5	1.1
3	.....	149	739	.....	.....	306	305	.....	4.1	.....	.5	1.1
4	.....	135	610	.....	.....	306	564	.....	4.1	.....	.5	1.1
5	.....	125	516	.....	.....	289	762	.....	3.7	.....	.5	1.5
6	.....	106	610	.....	.....	286	762	.....	3.7	.....	.5	1.5
7	.....	99	516	.....	.....	276	829	.....	3.7	.....	.5	1.5
8	.....	189	516	.....	.....	263	777	.....	73	.....	19.4	1.5
9	.....	1,430	464	.....	396	1,740	629	.....	88	.....	25	1.2
10	.....	923	377	.....	1,150	2,350	540	.....	78	.....	7.0	1.2
11	.....	610	377	.....	1,110	1,750	525	.....	69	.....	4.3	1.2
12	.....	464	330	.....	1,120	1,250	525	.....	51	.....	3.6	1.1
13	.....	330	330	.....	1,020	918	488	.....	51	.....	2.8	1.1
14	.....	256	292	.....	1,040	858	416	10.5	51	1.2	2.4	1.1
15	256	219	665	.....	702	653	431	8.6	51	1.1	2.1	1.1
16	230	204	1,210	.....	585	482	1,630	6.7	51	1.1	2.2	1.1
17	189	219	981	.....	435	384	1,890	6.1	44	.8	2.2	1.1
18	162	204	1,210	.....	[d]443	480	2,080	5.4	37	.8	2.2	1.1
19	189	219	872	.....	451	450	1,670	5.0	30	.7	2.2	1.1
20	189	219	665	.....	429	548	1,340	4.8	23	.5	2.2	2.6
21	162	204	464	.....	411	732	836	6.7	16	.5	2.2	2.2
22	162	189	419	.....	300	687	713	6.7	8.2	.5	1.5	2.2
23	219	162	374	.....	306	510	543	7.0	9.2	.5	1.5	.....
24	204	155	330	.....	321	428	.....	6.1	10.2	.7	1.5	.....
25	219	162	256	.....	332	414	.....	4.8	11.2	.5	1.2	.....
26	162	155	256	.....	442	528	.....	4.5	12.2	.5	1.2	.....
27	149	162	219	.....	406	506	.....	4.5	13.2	.5	1.2	.....
28	149	189	189	.....	347	477	.....	4.5	14.2	.5	1.2	.....
29	125	182	162	.....	329	491	.....	4.5	15.2	.5	1.1	.....
30	116	162	189	.....	291	527	.....	4.7	.....	.5	1.1	.....
31	135	135	.....	.....	254	408	.....	4.8	.....	.5	1.1	.....
Mean	177	267	483	176	549	642	824	5.88	28.8	0.661	3.09	1.35
Mean per square mile	0.244	0.369	0.667	0.243	0.273	0.319	0.410	0.203	0.993	0.112	0.524	0.229
Run-off (depth in inches on drainage area)	0.15	0.42	0.74	0.02	0.23	0.37	0.35	0.14	1.07	0.07	0.60	0.19

[a] The rating curve for this station is well defined below 400 second-feet discharge.

[b] Drainage area of the North Fork at the "kink" is 74 per cent of that of the Fortymile at Steele Creek minus that of the South Fork at Franklin Creek. Daily discharges at the "kink" were obtained by taking 74 percent of the difference in discharge between the Fortymile at Steele Creek and the South Fork at Franklin Creek.

[c] The discharges at this station for Aug. 13–15, 17–21, and 23–28 were determined by comparative hydrographs and interpolation.

[d] Mean of the 17th and 19th.

Miscellaneous measurements in North Fork of Fortymile River drainage basin in 1910.

Date.	Stream and locality.	Drainage area.	Discharge.	Discharge per square mile.
		Sq. miles.	*Sec.-ft.*	*Sec.-ft.*
July 18	North Fork of Fortymile River above Slate Creek.	109	16.8	0.15
July 15	North Fork of Fortymile River at "kink"	2,010	897	.45
Aug. 8	do	2,010	425	.21
July 18	Slate Creek at mouth	336	40	.12
Aug. 26	Champion Creek below Arkansas Creek	43.4	8.8	.20
Sept. 11	do	43.4	13.8	.32
Aug. 25	Champion Creek above Bear Creek	125	14.1	.11
July 17	Champion Creek at mouth	179	78	.44
Aug. 25	Bear Creek at mouth	48.0	9.0	.19
July 16	Middle Fork of Fortymile River at mouth	1,110	397	.36
Aug. 22	Bullion Creek at mouth	34.3	14.6	.43
July 13	Hutchinson Creek below Confederate Creek	16.6	7.3	.44
July 14	do	16.6	5.8	.35
Aug. 7	do	16.6	1.7	.10
Aug. 9	do	16.6	35	2.11
Aug. 21	do	16.6	3.9	.23

EAGLE DISTRICT.

LOCATION OF AREA.

The Eagle district in this report is considered as the area drained by Mission Creek and its tributaries. It lies in the Eagle precinct and the town of Eagle is the center of commercial activity. It was topographically surveyed in 1898 and is covered by the map of the Fortymile quadrangle.

GAGING STATIONS AND MEASURING POINTS.

The following list gives the locations at which gaging stations were maintained or discharge measurements made in 1910 in the Eagle district:

Gaging stations and measuring points in Eagle district, 1910.

Mission Creek drainage basin:
- Mission Creek above Colorado Creek.
- Mission Creek above American Creek.
- Excelsior Creek at mouth.
- American Creek at claim "No. 8 above."
- American Creek at United States pumping plant.
- Discovery Fork of American Creek below Star Gulch.

MISSION CREEK DRAINAGE BASIN.

Mission Creek drains a circular-shaped area of 170 square miles lying between Fortymile and Seventymile rivers. It enters the Yukon at the town of Eagle and has a length of about 30 miles. It flows generally northeastward to Excelsior Creek, where it makes a sharp turn and takes a southeastward course for 8 miles to its mouth. Its most southern waters rise at an elevation of about 4,000 feet in the divide at the head of O'Brien Creek, and its two largest tributaries from the west, Seward and Excelsior creeks, drain a portion of the eastern slope of Glacier Mountain, which reaches an elevation of 6,000 feet. Above Excelsior Creek the valley is bordered by high, precipitous slopes on either side. Below the big bend to the east the stream channel follows closely the northern part of the valley, which has a steep and narrow drainage slope to the north, whereas on the south the slope to the summit of the divide is very gradual.

American Creek is the largest tributary of Mission Creek and joins it from the south about a mile from the Yukon. It flows northeastward and is about 18 miles in length. Discovery Fork is its chief branch and enters American Creek about 8 miles from the head. Above Marion Creek, which is a small feeder from the east, the valley is sharply V-shaped and in some portions is almost canyon-

like, being inclosed on either side by barren rocky slopes. Below Marion Creek the valley gradually broadens until it finally loses its identity in the Mission Creek Flats. The average grade through that portion in which mining has been carried on is about 125 feet to the mile. The total fall from the head to the mouth is about 2,000 feet.

Wolf Creek is tributary from the south about halfway between American and Excelsior creeks.

Spruce is the prevailing timber. An abundant supply is available for fuel, and in the Mission Creek valley considerable quantities of a size suitable for saw logs are to be found.

Daily discharge, in second-feet, of Mission Creek and Discovery Fork of American Creek for 1910.

Day.	Mission Creek above Colorado Creek[a] (drainage area, 84.81 square miles).			Discovery Fork of American Creek below Star Gulch[b] (drainage area, 14.8 square miles).			
	June.	July.	Aug.	June.	July.	Aug.	Sept.
1	.....	239	70	.....	2.7	1.0	2.7
2	.....	93	56	.....	1.5	1.0	36
3	.....	70	48	.....	1.2	2.0	24
4	.....	70	42	.....	1.2	3.0	12.4
5	.....	251	42	.....	1.2	6.0	12.4
6	.....	70	38	.....	1.2	10.0	10.4
7	.....	56	.....	.....	.9	14.6	8.4
8	.....	48	.....	.....	.9	44	6.3
9	.....	48	.....	.....	.9	12.4	10.2
10	.....	42	.....	.....	.8	10.0	8.4
11	.....	42	.....	.....	2.7	8.0	8.4
12	.....	93	.....	.....	73	6.0	6.3
13	.....	84	.....	.....	24	4.0	8.0
14	.....	56	.....	.....	10.2	3.8	12.4
15	.....	42	.....	.....	2.7	3.2	12.4
16	.....	48	.....	.....	2.7	3.8	14.6
17	.....	48	.....	.....	1.5	3.8	21
18	.....	42	.....	.....	1.5	4.3	12.4
19	.....	42	.....	.....	2.7	4.2	11.2
20	.....	42	.....	.....	1.5	4.2	10.2
21	.....	48	.....	.....	1.5	4.1	9.0
22	.....	62	.....	.....	1.5	4.1	7.5
23	.....	56	.....	.....	1.5	4.0	6.3
24	.....	48	.....	.....	1.5	4.0	6.3
25	111	42	.....	.....	1.5	3.9	6.7
26	102	42	.....	.....	1.5	3.8	7.1
27	102	42	.....	2.7	1.5	3.2	.....
28	124	38	.....	10.2	.8	3.2	.....
29	144	38	.....	40	.8	3.0	.....
30	124	35	.....	10.2	.8	3.0	.....
31	.....	84	.....	.....	.8	2.8	.....
Mean	118	66.5	49.3	15.8	4.80	6.08	11.2
Mean per square mile	1.39	0.784	0.581	1.07	0.324	0.411	0.757
Run-off (depth in inches on drainage area)	0.31	0.90	0.13	0.16	0.37	0.47	0.73

[a] The discharges at this station are fairly well defined between 50 and 110 second-feet.

[b] The rating curve for this station is well defined below 25 second-feet. A considerable part of the discharges during August were determined by comparative hydrographs, but the figures given are probably correct within 10 per cent.

Daily discharge, in second-feet, of American Creek for 1910.

Day.	American Creek at claim "No. 8 above" (drainage area, 24.1 square miles).				American Creek at United States pumping plant (drainage area, 67.3 square miles).				
	June.	July.	Aug.	Sept.	June.	July.	Aug.	Sept.	Oct.
1	.....	19.4	8.0	7.7	.....	24	22	22	36
2	.....	12.6	7.7	36	.....	45	22	57	36
3	.....	12.6	7.4	25	.....	34	22	146	22
4	.....	10.4	7.1	14.6	.....	24	15.0	87	22
5	.....	[a]145	6.8	12.6	.....	75	11.2	57	22
6	.....	36	6.5	11.4	.....	45	13.1	57	22
7	.....	17.0	6.2	10.1	.....	24	13.1	50	22
8	.....	12.6	31	8.9	.....	22	30	42	22
9	.....	10.4	36	13.0	.....	22	[a]541	42	30
10	.....	8.9	[a]84	19.4	.....	15.0	87	50	22
11	.....	14.6	71	14.6	.....	15.0	75	50	22
12	.....	17.0	54	8.9	.....	30	57	42	22
13	.....	10.4	17.0	11.6	.....	42	50	42	22
14	.....	8.9	12.6	14.6	45	42	50	50	.....
15	.....	7.7	8.9	42	42	42	26	165	.....
16	.....	7.7	8.9	44	50	32	30	114	.....
17	.....	7.7	8.9	44	[a]779	22	30	99	.....
18	.....	7.7	8.9	30	208	42	30	122	.....
19	.....	8.9	8.9	17.0	99	42	26	87	.....
20	.....	7.7	8.9	17.0	75	22	42	50	.....
21	.....	7.7	8.9	17.0	57	22	32	42	.....
22	.....	7.7	8.9	.....	42	22	36	42	.....
23	.....	7.7	8.9	.....	42	42	36	42	.....
24	.....	7.7	8.9	.....	34	30	26	42	.....
25	.....	7.7	8.9	.....	30	22	26	42	.....
26	12.6	7.2	8.9	.....	24	30	30	42	.....
27	12.6	6.7	8.9	.....	24	15.0	30	42	.....
28	12.6	6.2	6.9	.....	22	15.0	30	30	.....
29	10.4	5.7	4.9	.....	26	15.0	26	30	.....
30	54	5.7	4.5	.....	30	15.0	22	36	.....
31	.....	8.3	4.2	.....	.....	15.0	22	.....	.....
Mean	20.4	14.9	15.9	20.0	95.8	29.2	48.7	60.7	24.8
Mean per square mile	0.846	0.618	0.660	0.830	1.42	0.434	0.724	0.902	0.368
Run-off (depth in inches on drainage area)	0.16	0.71	0.76	0.65	0.90	0.50	0.83	1.01	0.18

[a] These discharges are only approximate.

Miscellaneous measurements in Mission Creek drainage basin in 1910.

Date.	Stream and locality.	Drainage area.	Discharge.	Discharge per square mile.
		Sq. miles.	*Second-feet.*	*Second-feet.*
June 13	Mission Creek above American Creek	168	225	1.34
June 23	Excelsior Creek at mouth	31.1	33	1.06
Aug. 29	....do	31.1	23	.74
Sept. 8	....do	31.1	43	1.38
Aug. 29	Wolf Creek at road crossing	28.4	12.0	.42
Sept. 8	....do	28.4	20	.70

SEVENTYMILE DISTRICT.

LOCATION OF AREA.

The Seventymile district includes the area drained by Seventymile River and that lying to the north of the Seventymile and south of the Yukon. This district lies entirely within the Eagle precinct, and Eagle is the supply point for the mines. The maps showing the area are those of the Fortymile and Circle quadrangles.

GAGING STATIONS AND MEASURING POINTS.

The following list gives the locations at which gaging stations were maintained or discharge measurements made in 1910 in the Seventymile district:

Gaging stations and measuring points in Seventymile district, 1910.

Seventymile River drainage basin:
- Seventymile River above Flume Creek.
- Seventymile River at the falls.
- Flume Creek one-fourth mile above mouth.
- Flume Creek ditch near outlet.
- Alder Creek at claim "No. 7 above."
- Deep Creek at mouth.
- Nugget Creek at mouth.
- Granite Creek above forks.
- Granite Creek below forks.
- Barney Creek at ditch intake.
- Barney Creek at mouth.
- Sonickson Creek at ditch intake.
- Sonickson Creek ditch at outlet.
- Mogul Creek at mouth.
- Crooked Creek below Eldorado Creek.
- Bryant Creek 2 miles above mouth.

Washington Creek drainage basin:
- Washington Creek below forks.

SEVENTYMILE RIVER DRAINAGE BASIN.

Seventymile River has its source in a relatively high and rugged divide east of Charley River. It flows east for about 60 miles to a point 4 miles from its mouth, where it makes a right-angle turn and flows north, joining Yukon River about 20 miles below Eagle. The drainage area is 667 square miles and is extremely unsymmetrical with respect to the river valley, as over three-fourths of it lies to the south.

The principal tributaries from the south, beginning with the headwaters, are Diamond Fork, Flume, Alder, Granite, Green, Sonickson, Mogul, and Bryant creeks. From the north Barney, Washington, and Crooked creeks are the principal streams, although much smaller than those from the south.

Extensive bench formations occur throughout the Seventymile Valley. Above the falls, which are located about one-half mile below Washington Creek, the river flows through a rather broad gravelly flood plain, but below the falls it is more closely confined and along a considerable part of its course has cut a rock canyon 20 to 30 feet deep. At the falls the river has a drop of about 9 feet in a horizontal distance of less than 200 feet. From Diamond Fork to the mouth, a distance of 53 miles following the general trend of the valley, the river has a fall of over 2,000 feet. From Diamond Fork to Barney Creek the river falls 1,400 feet in 25 miles and from Flume Creek to Barney Creek there is a drop of 600 feet in 15 miles.

Daily discharge, in second-feet, of Seventymile River for 1910.

Day.	Seventymile River above Flume Creek (drainage area, 129 square miles).[a]					Seventymile River at the falls (drainage area, 465 square miles).[b]			
	June.	July.	Aug.	Sept.	Oct.	June.	July.	Aug.	Sept.
1	.....	108	518	108	70	.....	322	602	275
2	.....	137	272	412	68	.....	400	548	760
3	.....	102	152	325	.....	.....	258	360	1,020
4	.....	100	124	298	.....	.....	380	290	938
5	.....	278	108	314	.....	.....	520	270	830
6	.....	124	89	257	.....	.....	322	225	865
7	.....	96	2,280	247	.....	.....	465	208	830
8	.....	74	1,390	186	.....	.....	208	4,300	575
9	.....	60	481	179	.....	.....	210	4,430	575
10	.....	108	446	205	.....	.....	300	1,550	695
11	.....	555	288	179	.....	.....	650	865	575
12	.....	674	205	146	.....	.....	1,100	586	520
13	.....	383	168	146	.....	.....	1,350	975	465
14	.....	186	186	239	.....	.....	380	680	619
15	.....	137	152	503	.....	.....	305	380	1,600
16	.....	117	168	402	.....	662	340	434	1,230
17	.....	100	168	325	.....	2,120	262	420	1,060
18	.....	137	247	247	.....	2,250	290	492	865
19	278	205	272	166	.....	938	420	630	662
20	341	112	186	137	.....	1,020	290	465	520
21	267	92	137	132	.....	695	262	400	440
22	247	122	112	128	.....	760	380	340	360
23	288	104	102	124	.....	830	305	275	360
24	183	124	98	122	.....	575	305	275	368
25	183	102	92	102	.....	400	290	262	380
26	162	100	108	92	.....	400	262	270	360
27	122	76	112	84	.....	340	222	360	360
28	159	74	124	70	.....	830	208	456	230
29	156	76	104	82	.....	520	250	340	225
30	112	76	106	70	.....	420	223	305	225
31	.....	518	92	.....	.....	.....	975	281	.....
Mean	208	170	293	202	69	851	402	719	626
Mean per square mile	1.61	1.32	2.27	1.57	0.535	1.83	0.865	1.55	1.35
Run-off (depth in inches on drainage area)	0.72	1.52	2.62	1.75	0.04	1.02	1.00	1.79	1.51

[a] Discharges at this station above 400 second-feet are only approximate.
[b] Discharges at this station above 1,500 second-feet are only approximate.

Daily discharge, in second-feet, of Flume and Alder creeks for 1910.

Day.	Flume Creek ¼ mile above mouth (drainage area, 36.7 square miles).[a]				Alder Creek at claim "No. 7 above" (drainage area, 11.8 square miles).[b]				
	June.	July.	Aug.	Sept.	June.	July.	Aug.	Sept.	Oct.
1	.....	22	86	21	.....	9.8	15.2	8.2	7.7
2	.....	26	50	40	.....	9.8	11.5	14.0	7.1
3	.....	19.6	34	66	.....	9.2	10.6	24	7.7
4	.....	17.9	27	63	.....	15.2	9.2	25	7.3
5	.....	38	23	61	.....	12.9	9.2	31	6.7
6	.....	28	18.7	56	.....	10.6	8.2	29	.....
7	.....	22	16.4	44	.....	9.8	8.2	18.5	.....
8	.....	16.5	192	39	.....	9.2	45	15.2	.....
9	.....	17.3	181	35	.....	9.2	70	11.5	.....
10	.....	13.9	106	42	.....	8.8	56	17.0	.....
11	.....	14.3	63	42	.....	9.8	33	12.9	.....
12	.....	113	54	32	.....	9.8	18.5	12.1	.....
13	.....	26	42	30	.....	9.8	12.9	11.5	.....
14	.....	15.8	36	37	.....	9.2	10.6	14.0	.....
15	.....	20	37	97	.....	9.2	10.6	56	.....
16	.....	42	39	83	.....	9.2	10.6	42	.....
17	.....	30	37	67	.....	8.8	10.6	27	.....
18	.....	49	37	55	.....	12.1	10.6	20	.....
19	67	56	42	45	.....	12.9	9.8	12.9	.....
20	86	37	35	38	24	9.8	9.2	9.2	.....
21	65	28	26	34	12.9	11.5	9.2	10.6	.....
22	69	28	19.4	31	14.0	10.6	9.2	8.2	.....
23	68	22	18.5	28	12.9	9.8	8.8	7.3	.....
24	47	18.9	16.7	25	11.5	9.8	8.2	7.3	.....
25	26	18.5	15.6	23	11.5	9.8	8.2	7.3	.....
26	34	16.9	17.1	23	10.6	9.8	8.2	7.3	.....
27	28	15.5	18.6	22	10.6	8.8	8.2	7.3	.....
28	53	14.3	17.0	.....	12.1	9.2	9.8	7.9	.....
29	40	16.9	17.1	.....	9.8	8.2	9.2	8.5	.....
30	28	19.4	24	.....	9.2	8.8	9.2	9.2	.....
31	.....	115	21	.....	.....	32	8.2	.....	.....
Mean	50.9	30.2	44.1	43.7	12.6	10.8	15.4	16.4	7.3
Mean per square mile	1.39	0.823	1.20	1.19	1.07	0.915	1.31	1.39	0.619
Run-off (depth in inches on drainage area)	0.62	0.95	1.38	1.19	0.44	1.05	1.51	1.55	0.12

[a] The rating curve for this station is well defined below 100 second-feet discharge previous to Aug. 7; after that date it may be slightly in error, due to shifting channel conditions.

[b] The discharges given at this station are probably correct within 10 per cent for all those below 40 second-feet.

Daily discharge, in second-feet, of Barney, Sonickson, and Crooked creeks for 1910.

Day.	Barney Creek above ditch intake.[a]				Sonickson Creek above ditch intake (drainage area, 12.6 square miles).[b]				Crooked Creek below Eldorado Creek (drainage area, 17.2 square miles).			
	June.	July.	Aug.	Sept.	June.	July.	Aug.	Sept.	June.	July.	Aug.	Sept.
1	.....	0.6	0.8	1.1	.....	4.0	6.2	10.2	.....	4.4	1.9	4.4
2	.....	.6	.7	4.1	.....	3.7	5.8	30	.....	3.4	1.9	16.0
3	.....	.6	.6	7.1	.....	3.3	5.4	51	.....	2.6	1.4	29
4	.....	.6	.5	6.7	.....	3.0	5.0	42	.....	3.4	1.4	22
5	.....	2.8	.4	6.2	.....	2.9	4.5	34	.....	4.4	1.0	22
6	.....	1.2	.4	5.7	.....	2.8	4.0	30	.....	3.4	1.0	20
7	.....	1.0	1.0	5.2	.....	2.7	5.5	26	.....	2.6	1.0	14.0
8	.....	.8	3.5	4.7	.....	2.5	7.0	26	.....	1.9	c139	8.4
9	.....	.6	13.4	4.2	.....	2.5	192	26	.....	1.4	c119	12.0
10	.....	.6	11.7	3.7	.....	2.5	55	24	.....	1.4	28	18.0
11	.....	.6	3.7	.....	.....	3.2	34	21	.....	1.9	18.0	16.0
12	.....	.7	1.8	.....	.....	3.9	17.7	19	.....	3.4	10.2	12.0
13	.....	.8	1.8	.....	.....	4.6	13.0	17.7	.....	2.6	7.0	12.0
14	.....	.9	1.5	.....	.....	5.3	11.2	20	.....	1.9	5.5	25
15	.....	.8	1.2	.....	.....	5.0	10.7	26	3.4	1.9	5.5	46
16	.....	.6	.9	.....	8.8	4.5	10.2	32	5.5	1.4	7.0	28
17	.....	.6	1.2	.....	310	4.0	10.2	39	43	1.4	7.0	34
18	2.8	.6	1.5	.....	61	4.6	10.6	.....	28	1.9	12.0	25
19	2.0	.6	1.8	.....	20	10.2	10.0	.....	14.0	2.6	10.2	20
20	.9	.4	1.5	.....	17.7	7.9	9.5	.....	8.4	1.9	8.4	25
21	.9	.5	1.2	.....	9.5	6.2	8.7	.....	7.0	1.9	7.0	.....
22	.6	.6	.9	.....	9.5	12.8	7.9	.....	4.4	4.4	5.5	.....
23	.5	.6	.9	.....	8.4	19.3	7.2	.....	4.4	3.4	5.5	.....
24	.4	.6	.9	.....	6.2	13.9	8.4	.....	3.5	4.4	5.5	.....
25	.4	.6	.9	.....	5.3	12.8	8.4	.....	2.6	3.4	5.5	.....
26	.5	.6	.9	.....	4.9	6.2	8.4	.....	2.6	2.6	5.5	.....
27	.6	.6	.9	.....	6.8	5.8	9.0	.....	7.0	1.9	5.5	.....
28	1.2	.6	.9	.....	5.7	5.4	10.1	.....	7.0	1.4	5.5	.....
29	1.2	.7	.9	.....	4.6	5.0	11.2	.....	7.0	1.4	4.4	.....
30	1.2	.8	.9	.....	4.3	5.4	9.5	.....	8.4	1.4	4.4	.....
31	.....	.9	.9	.....	.....	5.9	9.8	.....	.....	1.9	4.4	.....
Mean	1.02	0.745	1.94	4.87	32.2	5.86	17.0	27.9	9.76	2.51	14.4	20.4
Mean per square mile	.....	.....	.....	.....	2.56	0.465	1.35	2.21	0.567	0.146	0.837	1.19
Run-off (depth in inches on drainage area)	.....	.....	.....	.....	1.43	0.536	1.56	1.40	0.34	0.17	0.96	0.88

[a] The discharges at this station are based on gage readings taken about every 4 days and are only approximate, owing to shifting channel conditions.

[b] The discharges at this station for July 9–13 and 25–28, Aug. 2–5, and several shorter periods are estimated from comparative hydrographs. The rating curve is well defined below 80 second-feet.

[c] Approximate.

Miscellaneous measurements in Seventymile River drainage basin in 1910.

Date.	Stream and locality.	Drainage area.	Discharge.	Discharge per square mile.
		Sq. miles.	*Sec.-ft.*	*Sec.-ft.*
June 20	Flume Creek ditch near outlet	.....	2.6	.....
July 20	....do	.....	2.5	.....
Sept. 5	....do	.....	3.5	.....
June 21	Deep Creek at mouth	4.8	3.1	0.65
Do	Nugget Creek at mouth	2.7	.47	.17
July 18	Granite Creek above forks	68.1	10.4	.15
Do	Granite Creek below forks	112	22	.20
June 18	Barney Creek at mouth	.....	4.3	.....
June 22	Sonickson Creek ditch at outlet	.....	2.8	.....
June 16	Mogul Creek at mouth	64.4	79	1.23
Aug. 30	....do	64.4	47	.73
June 15	Bryant Creek 2 miles above mouth	21.4	21	.98
Aug. 29	....do	21.4	27	1.26
Sept. 8	....do	21.4	19.2	.90

WASHINGTON CREEK DRAINAGE BASIN.

Washington Creek rises in the divide north of the Seventymile and flows northward for about 25 miles to its junction with the Yukon. At the head the basin is about 18 miles wide and is drained by several large tributaries which reach from Barney Creek on the east to a point about opposite Flume Creek on the west. Ten miles below the head the basin is abruptly contracted to a width of about 6 miles and it averages about that width to the mouth. The headwaters flow through broad valleys, which have gentle slopes rising to a uniform altitude of about 3,000 feet. The drainage area above the mouth is 190 square miles.

Just below the junction of two small feeders, which form the headwaters of the main stream and rise in the divide at the west of Barney Creek, a measurement was made August 31 to determine the quantity of water on that day available for diversion over the divide to be used for hydraulicking on Pleasant Creek, which is a small stream entering Seventymile River from the north just above Barney Creek. No accurate survey had been made, and it is doubtful if water could be carried over the divide in a ditch with the intake below the forks. It was difficult to obtain an accurate measurement because the stream flows through a flat, swampy area in a deep-cut channel with overhanging muck banks. A discharge of 0.78 second-foot was recorded.

MINERAL RESOURCES OF THE BONNIFIELD REGION.

By STEPHEN R. CAPPS.

INTRODUCTION.

The region covered by this report lies on the north slope of the Alaska Range between Nenana and Delta rivers, and in a general way is limited on the south by the crest of the range and on the north by the Tanana Flats. It therefore forms a belt about 30 miles wide and 110 miles long, extending from Nenana River eastward to the Delta. That portion between Nenana and Little Delta rivers has been widely known as the Bonnifield region, which is here considered to extend eastward to Delta River. Since the establishment of Fairbanks as an important mining camp the area south of the Tanana has been visited by large numbers of prospectors, and although no strikes of exceptional richness have been made placer gold is widely distributed and has been found in paying quantities on a number of creeks. Further attention has been attracted to this region by the extensive fields of lignite, by reports of large bodies of low-grade gold-bearing ore, and by the possibilities of profitably developing some of the great gravel benches which carry a low content of placer gold.

The western border of this area was visited in 1902 by Alfred H. Brooks [1] and L. M. Prindle, the results of their work being embodied in a report now in press. In 1906 Prindle again visited that part of the area lying between Nenana and Wood rivers, and a brief account of his work has been published.[2] The notes, traverses, and manuscript of both of these investigators have been freely drawn upon by the present writer, who has also been greatly aided by them in personal conferences in the office. The organization of the field party and its itinerary are discussed on page 11 of this volume.

GENERAL DESCRIPTION OF THE REGION.

GEOGRAPHIC FEATURES.

The region bounded by Nenana, Tanana, and Delta rivers may be divided into three distinct east-west belts of different topographic character. On the north the Tanana Flats extend from Tanana River to the foothills. As Tanana River makes a broad loop north-

[1] Brooks, A. H., and Prindle, L. M., The Mount McKinley region, Alaska: Prof. Paper U. S. Geol. Survey No. 70, 1911.

[2] Prindle, L. M., Bull. U. S. Geol. Survey No. 314, 1907, pp. 205–226.

ward between the mouths of Nenana and Delta rivers, this flat is of varying width, being about 30 miles wide along the Nenana, 50 miles south of Fairbanks, and 20 miles on the west side of Delta River. This great lowland area is of slight relief, broken only by a few isolated hills which rise above the general level of the plain. Most of it is heavily timbered with spruce, and the drainage is so poorly developed that numerous lakes and marshes make summer travel over the greater portion of it impossible. Along its southern edge the Tanana lowland ends abruptly, giving place to a belt of foothills which stretch southward from 15 to 20 miles beyond the flats. These hills form minor east-west ranges parallel to the higher mountains to the south and have for the most part rounded summits and long connecting ridges of smooth outlines, ranging in elevation from 2,500 to 3,500 feet, although here and there hills with somewhat sharper peaks rise to heights of 4,000 or 5,000 feet. Between the ranges of hills there are in places broad structural valleys. The third belt comprises the rugged mountains of the Alaska Range, which here trends nearly east and west, and though not so high as that part west of the Nenana its loftier peaks are snow covered and support vigorous glaciers. The highest peak in this region, Mount Hayes, with an altitude of 13,800 feet, is a conspicuous landmark through much of the Tanana country. (See Pl. X.)

The drainage throughout the region is tributary to the Tanana. The larger streams rising in the higher ranges and flowing southward cut transversely across the foothill ranges, in many places with deep, narrow canyons, but many of the streams from the foothills follow the east-west transverse valleys to join the larger north-south streams. The most important streams of the area, from west to east, are Nenana River, Totatlanika and Tatlanika creeks, Wood and Little Delta rivers, Delta Creek, and Delta River. Only those streams of considerable volume maintain definite channels to the Tanana, the smaller creeks being absorbed by the flats, which are drained by irregular swampy streams.

As supplies can be transported to the hills much more cheaply by sledding in the winter than by trail in summer, few trails have been built in this region. An old Indian trail from the Tanana up the Nenana has been cut out and widened, but numerous forest fires during the summer of 1910 were followed by the falling of the timber, and much of this trail is now obliterated. A trail from the mouth of Wood River to the diggings on Tatlanika and Gold King creeks is passable during the summer months, and a good winter road from Gold King Creek to Fairbanks has been chopped out. Another feasible route to Dry Creek and Wood River follows the military winter road from Washburn across the flats and then swings southwest over the bare ridges. A fourth route, but little used, leaves the

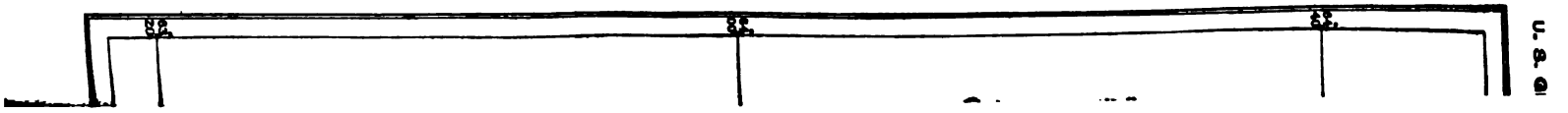
Valdez-Fairbanks road near Donnelly's and follows the low hills westward. Fairbanks and Tanana River points form the base of supplies for the region, and the greater part of the expense of freighting is usually incurred between the river and the creeks.

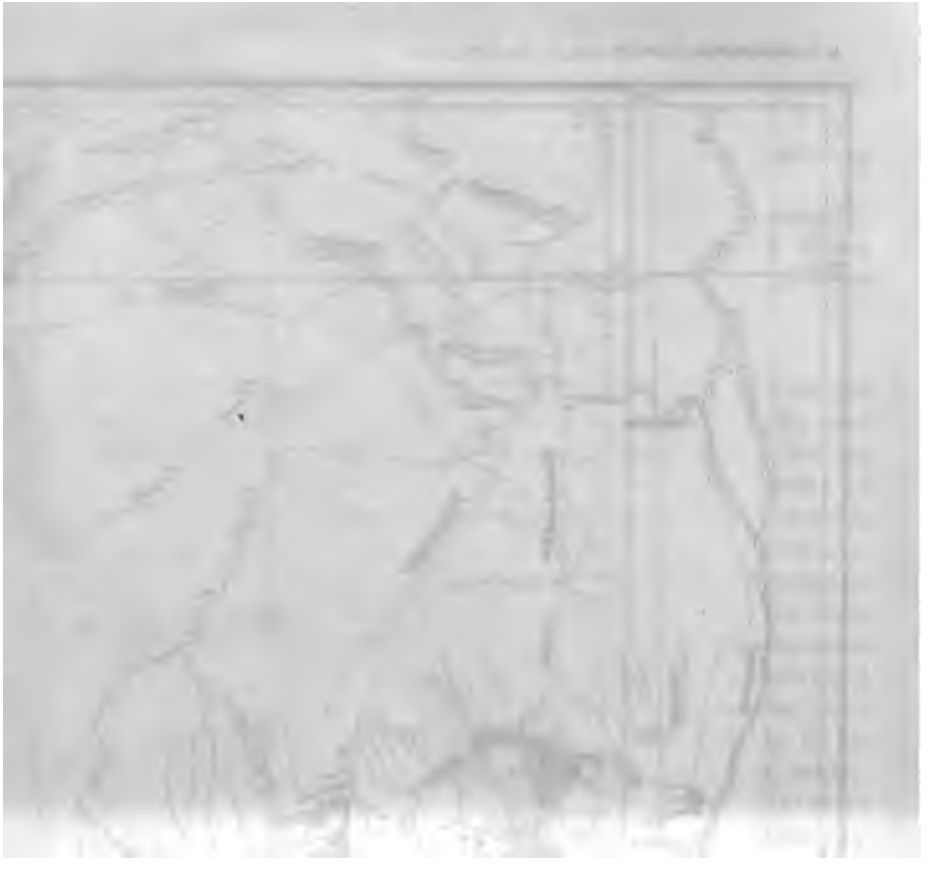
Horse feed is found nearly everywhere in the summer months, either along the stream valleys or in the heads of the small draws above timber, which commonly grows to an elevation of 2,000 to 2,500 feet.

GENERAL GEOLOGY.

The geologic formations represented in the region include an old schist series composed of metamorphosed sedimentary rocks and another schist series of metamorphic igneous rocks, both having been cut by large bodies of intrusives; much younger deposits of loosely cemented and somewhat folded beds; high bench gravels but little deformed; and more recent glacial and alluvial deposits. The old schists formed from metamorphosed sediments compose the greater part of the main range of mountains. They consist for the most part of quartz-mica schists with quartzites, cherts, and carbonaceous schists. Large bodies of granitic rocks have in places been intruded into these schists, and other varieties of igneous intrusives have been injected into and metamorphosed with the sediments in an intricate way. This series has been called the Birch Creek schist. The second schist series of altered igneous rocks forms the more important of the foothill ranges. It contains some sedimentary material, however, so that the two schist series in places show such intergradations that the boundaries are difficult to establish. Quartz-feldspar schists are the prevailing type, the rock being porphyritic over considerable areas, the feldspars occurring as conspicuous crystals with characteristic boundaries. These feldspars in places are over 2 inches in diameter, and many slopes are covered with crystals which have weathered out of the matrix.

Unconformably overlying the schists and occupying shallow warped basins between schist ridges are areas of Tertiary sediments consisting of slightly cemented sands and clays and beds of lignitic coal. The coal-bearing series when first deposited doubtless covered a much wider area than it does now. It probably covered all or nearly all of the foothill belt and may even now underlie large areas of the Tanana Flats. The beds vary in attitude from a nearly horizontal position to dips approaching the vertical, but in general occupy basins in the schists, the coal series dipping away from the bordering schists toward the centers of the basins. Overlying the coal series is a thick deposit of gravels, which is evidently of considerably later age than the coal series but which locally seems to be structurally continuous with it. The gravels have a total thickness of at least 1,500 feet and are in general less folded and tilted than the





coal beds. They, too, were formerly much more widespread than now, as is shown by the remnants of the beds and by scattered gravels over the tops of many of the foothill ranges. Still later in age than the high gravels are the glacial moraines and terraces and, latest of all, the extensive gravel deposits of the present streams.

MINERAL RESOURCES.

GOLD PLACERS.

GENERAL DESCRIPTION.

The locations in which placer gold in paying quantities has been found all lie in the foothill belt between the Tanana Flats and the high schist range to the south (See Pl. X.) Furthermore, the placers all occur in the valleys of the smaller streams which were either north of the area invaded by ice at the time of the maximum glaciation or which were themselves not occupied by glaciers. It may be that formerly there was a concentration of gold in the valleys of the main range, but if so this gold was removed by the ice and scattered throughout the moraine deposits, and postglacial erosion has been insufficient to reconcentrate it or to form new placers in its stead. Colors can be found in almost all the streams of the foothills, but gold in paying quantities has so far not been found between Little Delta and Delta rivers. The streams between Wood and Nenana rivers are peculiar in that in their northward course from the high mountains to the Tanana Flats they cross one or two, and one of them four, hard-rock ridges into which they have cut deep canyons with steep rock walls. Between the canyons the valleys widen out and have developed broad gravel floors. Wide areas in the foothill belt are occupied by high bench gravels, and scattered gravels on the crests of many of the schist ridges give strong evidence that the high gravels formerly covered all of this area north of the main range. All the workable placers have been found in the streams which have cut their valleys into these gravels or which drain areas formerly gravel covered. The high gravels have in many places been shown to carry a small amount of placer gold, and doubtless most of the present placer deposits have been derived from a reconcentration of the gold from these high gravels, although some gold may have been contained in the Tertiary beds and upon their erosion may have been reconcentrated along with that from the high gravels, and some may have been derived directly from the weathering of the schists.

With the exception of Moose Creek, a tributary of the Nenana, on which pay was first found in 1909, the list of producing creeks is much the same as it was when visited by Prindle in 1906, and the total number of men engaged in mining or prospecting is smaller than at that time. The creeks which were producing during the last season

are Moose, Totatlanika and its tributaries (Homestake, California, and Rex), two tributaries to Tatlanika from the east (Grubstake and Roosevelt), Gold King, and Portage creeks.

MOOSE CREEK.

Moose Creek is a small tributary of the Nenana from the east, joining that river about 10 miles above the Tanana Flats. It heads in a rounded schist ridge which was once capped by high gravels, and some remnants of these gravels still remain. The stream in its upper course occupies a valley cut in the schists, then cuts through beds of the coal-bearing series, below which it emerges upon the gravelly flats of the Nenana. The first production of consequence from this creek was in 1909, when it was reported that 100 ounces of gold was recovered during the last three weeks of the season, the pay being taken from a gravel bench with schist bedrock. It seems probable that the gold is a reconcentration from the high gravels which once covered the schist but most of which have now been removed by erosion. Seven men are reported to have been mining on this creek during 1910.

TOTATLANIKA BASIN.

Totatlanika Creek.—Totatlanika Creek is a stream of considerable size which enters the Tanana Flats about 16 miles east of the Nenana. It drains a basin in the hills about 275 square miles in area. It is formed by the confluence of a number of creeks which head in the high schist ridge north of Healy Fork. Below their confluence the stream flows through a succession of rock canyons and broad, open areas, the floor being narrow and difficult to travel in the canyons on account of the swift current of the stream, the steep rocky walls against which the stream cuts on one side or the other, and the accumulations of large bowlders and coarse blocky talus from the walls above. In the more open spaces between the canyons the valley floor widens, having a breadth of several hundred feet in places, and is composed of cobbles, fine gravels, and sands. The more important tributaries which join the main stream are Homestake, Buzzard, and California creeks below its junction with Rex Creek.

During the last six years a large number of men, encouraged by colors which can be found in almost all parts of the valley, have prospected along this stream from its head to the mouth of the lower canyon, and most of it has been staked during this period. Especially in the canyons where the gravels are shallowest are to be seen numerous old prospect pits and cuts. During 1910 all attempts to work ground on this stream had been abandoned except on a single claim, 2 miles below the mouth of Homestake Creek, where five men were engaged in mining. It is reported that the ground worked was yielding considerably more than wages.

There is abundant water for mining throughout this valley. In fact, the labor required in building wing dams and bedrock drains makes prospecting expensive even in periods of moderate run-off, and in times of high water the control of the stream is a serious problem to the prospector.

Homestake Creek.—Homestake Creek is a small tributary of the Totatlanika from the southwest and joins that stream in its upper canyon. Owing to the custom common among prospectors of giving different names to different parts of the same stream, the lower portion of this tributary is called Homestake and the upper portion Platt Creek. It heads in a broad, rolling depression bordered by schist ridges which extends between the Nenana and the head of Tatlanika Creek. This basin is underlain by unconsolidated beds of sands, clay, gravel, and lignite. Two miles below its source it leaves the open country to enter a narrow, steep-walled canyon through andesite mountains, broadening again somewhat before it joins the Totatlanika.

This valley has been prospected throughout its length, but workable placers have been found only in the canyon and in the open part of the valley just above it. Here mining has been in progress since 1906. The gravels are about 6 feet deep and lie on a decayed schist bedrock. The values occur in a well-defined pay streak 30 to 60 feet wide carrying reported values of about $3 to the cubic yard, the gold being found either on bedrock or in thin beds of oxidized yellowish gravels and sands. The ground being worked at the time of the writer's visit evidently received its gold from a small tributary which enters at that point. The gold is somewhat rusty and rather coarse, numerous pieces valued at $3 to $5 having been found. The greatest drawback to mining this ground is the scant water supply, less than a sluice head being available through the summer, so that it is necessary to hold the water with a dam until enough has accumulated to give a good volume for groundsluicing and to supply the sluice boxes.

In the canyon of Homestake Creek, below the mouth of a small tributary called Ptarmigan Creek, three men were engaged in mining, having been at work on this ground since 1906 with the exception of the season of 1908. Here the gravels average about 6 feet deep and lie on either a schist or an andesite bedrock. The values occur in a pay streak about 25 feet wide, and the gravels are reported to yield from $3 to $9 per square yard of bedrock. A sluice head or more of water is available for a season of about 80 days.

From the character of the gold and its distribution it seems probable that it has been derived from deposits of high gravels, most of which have now been removed by erosion.

It is estimated that the total production of Homestake and Platt creeks from 1906 to 1909, inclusive, has been about $50,000.

California Creek.—California Creek, which joins the Totatlanika at the head of its lower canyon, drains a considerable area in the vicinity of Jumbo Dome and has developed two canyons at points where it crosses schist ridges. Most of its course, however, is through a broad open country of rounded hills of gravels, sands, and lignite beds. Colors can be found in many parts of the basin of this stream, although no information was obtained of gold having been produced in commercial quantities. During the season of 1910 work was being done in but a single locality at the head of a canyon some 5 miles above the junction of California Creek with Rex Creek. Here two men had constructed a bedrock drain, in gravels about 6 feet deep lying upon a schist bedrock. At the time of visit the gold content of the gravels had not yet been determined, though panning tests seemed to show fair values.

Rex Creek.—Prospecting on Rex Creek has been carried on intermittently since 1905 by a number of men with but indifferent success. The creek, a tributary of the Totatlanika, heads in schist hills, some of which still have a portion of their ancient gravel capping. Some of its tributaries have sharp V-shaped valleys cut into the schist, but the valley of the main stream is broad and open and in its lower reaches lies in beds of sands, clay, and white quartz gravel, with some beds of lignite which are thought to correspond with the base of the Tertiary as exposed in Healy Creek.

Both the gravels of the main stream and the low bordering bench gravels carry gold which is in places sufficiently concentrated to yield good pay. The values, however, are unevenly distributed, especially on the benches, and no well-defined continuous pay streak has been found on them. In the main stream the difficulties of securing proper drainage have prevented thorough prospecting. The water supply on upper Rex Creek is too small for extensive workings, between one and two sluice heads being available during the summer.

The ground worked ranges up to 6 or 8 feet in depth, the pay all being found close to bedrock, which consists of decayed schist and into which the gold has penetrated to a depth of about a foot. The gold is bright and fairly coarse, and the gravels contain no bowlders too large to handle.

TATLANIKA BASIN.

Tatlanika Creek.—Tatlanika Creek drains an area east of the basin of the Totatlanika, the streams being 8½ miles apart where they reach the Tanana Flats. It is formed by the union of Sheep and Last Chance creeks, both of which head well back in the high mountains. These streams on emerging from the main range cross areas of much

slighter relief, then enter gorges cut through quartz-feldspar schists, and below their junction enter a broad open basin in unconsolidated sands, clays, gravels, and some lignite, through which the stream has developed a gravel floor many hundreds of feet in width. The coal-bearing series at this place is thought to be much younger than that occurring on California Creek. Through this broad basin the stream continues for more than 10 miles, abruptly entering another rock canyon from which it enters the gravel plain of the Tanana. In the basin above the lower canyon the Tatlanika receives tributaries from both the east and the west, those from the east being somewhat larger and having more deeply incised valleys. Three of the eastern tributaries, Grubstake, Roosevelt, and Hearst creeks, have yielded placer gold.

Grubstake Creek.—Mining has been carried on more or less continuously on Grubstake Creek since 1905, though only a few men have been employed there at any one time. The valley of the creek lies along the line where the high gravels join the schist ridge to the south and the basin includes portions of both the schist and the high gravel areas. Workable placers have been found only for a mile or two above the mouth of the stream, which has here cut a valley 200 to 300 feet deep through a wide gravel terrace into the beds of the underlying coal series. Where the stream gravels are worked they lie on a soft bedrock of clay, sand, or coal, the pay being found in the lower foot or two of the gravels or on the bedrock. The pay streak varies from 25 to 75 feet in width, and the gold is flat, well worn, and rather fine, containing few coarse pieces. Though the gravels contain some bowlders of a large variety of rocks, derived both from the high gravels and from the schist, most of the material is small enough to be easily handled. About one sluice head only of water is available throughout the season, so that operations are restricted to open-cut workings. It is reported that in 1910 two men were mining on this creek in ground which yielded a satisfactory return.

Roosevelt Creek.—Roosevelt Creek joins the Tatlanika about 3 miles below the mouth of Grubstake Creek. It heads in a high ridge composed of unconsolidated gravels, sands, and clays and has no hard bedrock within its basin. The workable placer ground lies in the lower 2 or 3 miles of the valley, which is here comparatively shallow and open, without high bordering ridges. The placer deposits occur in stream gravels supplied by erosion of the high gravel covering of the ridge in which the stream heads, and the placer gold is doubtless the product of the reconcentration of gold from the same high gravel beds. In the absence of hard bedrock the gold is concentrated on a soft bedrock, consisting of clayey or sandy layers of the coal-bearing series into which the stream has cut its channel.

The ground worked is shallow and the values are obtained from a pay streak 20 to 60 feet wide. The gold is flat and fine, and its worn appearance indicates that it has traveled far from its original source. An insufficient water supply has retarded development on this creek, and the production for the last few years has been unimportant. Mining was in progress at one place on a small scale during the season of 1910.

Hearst Creek.—Hearst Creek enters the Tatlanika from the east, a little more than a mile below the mouth of Roosevelt Creek, and also heads in the unconsolidated deposits, with the lower part of its valley cut into the sands and gravels of the coal-bearing series. In the absence of hard bedrock the gold has been concentrated upon the more favorable of the unconsolidated beds. Since 1905 a few thousand dollars' worth of gold has been recovered from this valley, but no information could be obtained of mining there during 1910.

GOLD KING CREEK.

Gold King Creek is the first stream of importance east of the Tatlanika and flows through the foothill belt with a course somewhat east of north to the Tanana Flats, in which it joins Wood River. It heads in a high ridge of quartz-feldspar schists through which it has cut a deep notch. From the schists it passes out into the area of high gravels, and its valley 10 miles below its head is incised 1,200 to 1,500 feet below the surface of the ridges to the east and west. These ridges were originally part of a gently sloping plain built up of gravels from the mountains to the north, and in many places portions of the original surface of this plain are still preserved. The materials are for the most part well-washed gravels of moderate size, with some sandy and clayey beds, but some portions of the deposit contain bowlders as much as 2 feet or more in diameter. The bowlders and pebbles are all of rocks which can be recognized as having come from the ridges to the north. The stream was nowhere observed to have cut down into the coal-bearing series which probably underlies the gravels.

Mining has been carried on in the stream gravels of Gold King Creek since 1903. The ground worked has ranged in depth from 2 to 8 feet, the principal drawback being the presence of many large bowlders, derived both from the rocks at the head of the valley and from the high gravels. The natural tendency for a stream cutting through gravel beds is to concentrate the large bowlders as well as the heavy metallic contents in the stream channel, the finer and lighter material being carried away. Water is usually sufficient for small mining operations, three or more sluice heads being available even in periods of low water, and in wet seasons the flow of the stream is large. The gold is said to assay $17.82 an ounce and is flat, well

worn, and rather fine. It is found either in the stream gravels or on a soft clayey bedrock. In 1910 mining operations were conducted on two claims, Nos. 19 and 21 below Discovery, and the yield at both places was reported to be satisfactory.

In the valley of Gold King Creek, as well as at a number of points in adjacent creeks, large areas of ground have been staked by those who intend to mine the extensive deposits of high bench gravels into which the stream valleys are cut and which cover a wide area all along the foothill belt in this region. These gravels in the valley of Gold Creek are more than 1,000 feet in thickness and no facts are known as to their depth in the valley bottom. For a number of years these high gravels have been known to be gold bearing, and from them many of the producing placers have been derived by stream concentration. Reports of men who have prospected in different parts of the high-gravel area show their gold content to range from fine colors to 3, 5, and even 15 or 20 cents to the cubic yard. The lower returns are usually from the gravels near the tops of the ridges, and the higher values have been found along the lower slopes. This fact is significant and probably indicates that the values in the richer ground have come from a concentration by erosion from the gravels above rather than that the actual gold content of the gravels increases as the deeper-lying beds are reached. Further evidence of the low average content of the high gravels can be obtained by comparing the amount of material eroded in those valleys which lie wholly within the area occupied by these gravels and the richness of the placers in these valleys. Although some of the gold derived from the high gravels might well be expected to have moved on down these streams, yet if the original gravels carried any considerable values it would be expected that the present stream gravels would be much richer than developments have so far proved them to be. Great care should therefore be exercised when prospecting the high gravels to drive tunnels far enough into the deposits to reach undisturbed beds which have certainly not been enriched by gold from above. Only by careful sampling in this way can the actual gold content of the beds be determined.

By far the largest project under way in the Bonnifield region, and one which may have a most important influence upon its future development, is that of the Berry & Hamil Co., which is making preparations to mine on a large scale the high gravels in which the basins of Gold King and Bonnifield creeks have been eroded. The company controls a large acreage of land in these two valleys. No mining has so far been done, but during the last summer 45 men were employed in building ditches and roads, erecting buildings, etc. It was expected that the ditches would be completed during the summer so that active work might be commenced early

in the spring of 1911. The ditches include one 2½ miles long and one 2 miles long, to take water from the heads of Mystic and Moose creeks, respectively, and drop it into the upper end of the Gold King drainage basin; another, 6½ miles long, to take the water from upper Gold King Creek to the cut on claim No. 5 below Discovery; and a fourth, a little more than a mile long, from Gold King to the cut. The long ditch, which is to supply water under pressure for the hydraulic giants, will carry 3,000 miner's inches of water and will give a head of 700 feet at the cut. This is more pressure than will be needed, but the ditch has been so laid out that its continuation will cross the ridge into the Bonnifield basin and will furnish sufficient water for operations on both streams. The giants, with 4-inch nozzles, have been set, and the cut opened so that sluicing may be begun without delay. The timber for flumes, sluice boxes, building, etc., is sawed at the company's mill located some miles below the mine workings. Most of the upper portion of the valley is timberless. So far as could be learned on the ground it appears that the deposit to be worked has not been extensively prospected, and its gold content can be accurately known only when some considerable body of it has been sluiced. Conditions should be favorable here for the handling of ground at a very low cost per cubic yard, as a very high gravel face will be had when the cut is run back into the hill a few hundred feet. Furthermore, although some large bowlders occur in the gravels, most of the material is fine enough to be readily handled with the giants, and with the high pressure available it is largely a question of water supply. If the ground proves to be rich enough to warrant it mining will be established on a permanent basis in this region, as the gravels are practically inexhaustible and are so widely distributed that the water from a large number of streams could be used in their exploitation.

DRY CREEK (LITTLE DELTA DRAINAGE).

Dry Creek heads in the high schist mountains and flows north to the Tanana Flats, draining a basin which lies just east of that of Wood River. In the foothills the stream has a large volume of water, but much of its water is said to sink into the gravels and disappear soon after reaching the flats. Above the mouth of Newman Creek, its largest tributary from the east, the valley is cut into schists. Below Newman Creek, for a distance of 5 miles, the stream flows through a wide valley cut through high gravels into the coal-bearing formation, then enters a schist canyon through which it flows for about 5 miles, emerging into the broad, flat valley of the Tanana.

The stream gravels of Dry Creek are known to carry gold, and the valley floor has been staked for a few miles above the mouth of Newman Creek and considerable prospecting done. The gravels are from

4 to 8 feet deep and lie upon schist bedrock. Pay as high as $3.50 per square yard of bedrock has been found, but large bowlders are numerous and the ground proved too wet to work without establishing a bedrock drain, an undertaking which has so far discouraged the owners.

Caribou Creek, a tributary of Dry Creek from the west about 7 miles below the mouth of Newman Creek, flows through a valley which is in high gravels at its head but in schist in its lower portion. In 1909 two men made fair wages by working the stream gravels, but the ground appears not to have been rich enough to encourage them to return, and no work was done on this stream during 1910.

Newman Creek drains a basin which includes schists, the coal-bearing series, and high gravels. The stream gravels carry some gold, and the high gravel hills are also auriferous, reported prospects from the upper beds of the high gravels showing a yield of 3 or 4 cents a cubic yard, with values increasing somewhat in the lower beds. At the base of the high gravels, which are similar to those already described for Gold King Creek (pp. 226–228), there is a bed of clean rounded white quartz pebbles, locally known as the "white channel," on which there seems to be some concentration of gold. Newman Creek has so far not produced gold in commercial quantities, but a project is under way to exploit the high gravels on a large scale. One party has staked 125 association claims of 120 acres each in the basins of Newman Creek and West Fork of Little Delta River, water for hydraulicking to be taken from the latter stream. It was expected that the ditch would be surveyed during September, 1910, and active construction started in the spring of 1911.

Portage Creek is a small tributary of West Fork of Little Delta River and has a basin in the high gravels east of the head of Newman Creek. Placer mining of the stream gravels has been carried on continuously for the last five years by one outfit, the pay being concentrated on a clay bedrock. No hard bedrock occurs in this gulch. The total production of the creek to date is estimated at $10,000.

LODE MINING.

The wide distribution of placer gold in the Bonnifield region has attracted the attention of many prospectors to the search for placer mines, yet comparatively few men have been seriously engaged in the search for the lodes that must have furnished the gold to the gravels. Both the geologic and the physiographic evidence at hand point to the high schist mountains of the Alaska Range as having been the ultimate source of the gold, and these mountains hold forth considerable promise to the hard-rock prospector. Associated with the schists of the main range which have been correlated with the Birch Creek schist of the Fairbanks region, and also cutting the quartz-feldspar

schists to the north, are many intrusive granitic rocks, and there is some reason to believe that the mineralization of the schists may be due to these intrusions. The schists in the neighborhood of such granite and diorite masses are therefore the most promising fields for the search for mineral-bearing lodes. Lode prospecting has so far been confined largely to the basin of Wood River.

CHUTE CREEK.

Chute Creek is a tributary of Wood River from the east. It is 5 or 6 miles long and flows in a deep narrow-bottomed gorge through a complex series of schists cut by intrusives. In 1908 a certain zone of the schist series was discovered by J. C. Rogers, a prospector, to be considerably mineralized with iron pyrite and to carry gold values. The lode is an altered igneous rock which weathers to conspicuous red and yellow colors and is filled with extremely small cubes of finely disseminated pyrite. The mineralization was observed to occur in a zone which has a width of over 100 feet, striking nearly north and south, and which has a high dip, so that a large body of pyritized rock is exposed. The same rock, or a very similar one, occurs in the valleys of Sheep Creek to the south and of Dry Creek to the east. In 1909 a 3-stamp mill was installed on Chute Creek and operated for about a month. In August of that year the mill was washed out by a freshet and it has since been removed to another part of the country. A 30-foot tunnel driven this year into the ore body shows no changes in the rock other than those due to protection from surface weathering.

The owners report that assays show a yield of $5 in free gold and $4 in concentrates.[1] The rock milled is also reported to have carried values of about $9 a ton. Assays of similar rocks from Chute, Sheep, and Dry creeks all showed traces of gold, though no attempt was made to sample any ore body. If further tests prove the average gold content of this mineralized zone to be anywhere nearly equal to the values reported, there is here an opportunity to develop mines in which the large supply of ore and the favorable conditions for mining should allow a liberal margin of profit over the cost of production. A rather good grade of lignite coal could be procured for power within 5 miles of the ore croppings.

KANSAS CREEK.

Kansas Creek is one of the larger tributaries of Wood River from the east. In its basin, as well as in that of Copper Creek, which enters opposite Kansas Creek from the west, bodies of a black quartzitic rock which are reported to carry gold values are associated with the schists. The only development work which has been done in these

[1] Brooks, A. H., Mineral resources of Alaska—Report on progress of investigations in 1909: Bull. U. S. Geol. Survey No. 442, 1910, p. 36.

bodies is on Kansas Creek, where, it is reported, a 90-foot tunnel has been driven into such a black quartzitic bed, which shows disseminated pyrite. No report of the assay value of this rock was obtained.

COAL DEPOSITS.

GENERAL DESCRIPTION.

The coal-bearing rocks referred to frequently in the preceding pages occupy a large area in the foothills north of the main range. They have their greatest known development and offer the best exposures on the western edge of the area under discussion and were visited as far eastward as Wood River and their approximate distribution mapped by L. M. Prindle in 1906. During the summer of 1910 further information was obtained regarding the areal extent of this important series, and numerous exposures were found which extend the limits of the formation eastward to the neighborhood of Delta River. Reports from prospectors also show that coal, probably of the same age, occurs both east of the Delta and west of the Nenana, so that further investigation may extend this field both east and west much beyond its limits as now known. It also seems highly probable that the coal series underlies parts of the areas of high gravels and of the Tanana Flats. From the facts now known no estimates can be made of the possible coal resources in the region where the formation is completely covered by later deposits, as the coal beds may there lie too far below the surface to be economically available, and the large supply of more easily accessible coal will certainly be used before an attempt is made to use that which is more deeply buried.

The coal-bearing beds, where best known, lie in low troughlike areas between the east-west ridges of schists which form the foothills. The series consists of sands, clays, gravels, and coal, the beds being in general but slightly cemented. The base of the series is composed of beds of pebbles and angular or partly rounded bits of quartz in a matrix of white sandy clay, or of kaolinic material, which where exposed is conspicuous for its whiteness. This is succeeded by alternating sands, clays, and coal, the coal beds being in general thicker toward the base of the series and becoming thinner toward its top. One section shows an aggregate of 230 feet of coal, of which over 200 feet is in beds 4 feet or more thick, and in other less complete exposures the total thickness of coal measured was in many places from 50 to 130 feet, single beds reaching thicknesses of 20, 30, or even 40 feet. In many places, too, certain of the coal beds have been burned out, leaving the adjacent beds burned to a bright tile-red. Where this has occurred, the beds just above are in places brecciated and much disturbed by caving down to fill the void left when the coal burned out. The red baked beds are much harder than the associated uncon-

solidated deposits and have retained the imprints of fossil leaves which show the coal series to be of Tertiary age.

The coal or more properly lignite beds of the Kenai formation vary considerably in character, being firm and compact and commonly very thick lignite beds near the base of the section but becoming thinner and more woody as the upper beds are reached. No openings were seen which would give an opportunity to collect fresh unweathered samples for analysis, but the surface croppings of the lower beds furnish a fuel which has had some small local use and which is said to burn freely and without much ash. Though probably of too low a grade to ever compete with the better coals of the coast for export, it would find a ready market for use in the interior of the Territory. It also offers exceptional opportunities for the development of power in the coal fields for electrical transmission to points in the Tanana Valley. Fairbanks is less than 60 miles from the nearest of these fields and well within the zone of economical transmission.

A heavy series of gravel beds overlies the Kenai formation at many points and was probably once continuous over much of the foothill area, but erosion has now removed the gravels in many places where their former presence is shown only by small patches or by scattered pebbles. The exact stratigraphic position of this gravel series is still in doubt and can be determined only by more detailed investigation. No determinable fossils have so far been found in it. It seems to be distinctly older than the glacial deposits and occurs at elevations above those reached by the ice at its greatest development, being folded and tilted more than the Pleistocene deposits. Near the Nenana it seems to be structurally conformable and continuous with the top of the coal-bearing beds and was thought by Prindle to be a continuation of the Kenai formation. At points farther east, however, it seems to overlie the Kenai unconformably, and the writer is disposed to think that an erosion interval elapsed after the Kenai before the high gravels were laid down. It is possible, however, that different conditions existed in different localities and that the gravels may be continuous and conformable with the coal-bearing beds in some places and unconformable in others.

LOCAL DESCRIPTIONS.

Healy Creek.—The valley of Healy Creek is occupied by the coal formation for about 10 miles above its mouth. In a general way these beds form a synclinal trough with its axis parallel to the valley. The stream follows the trough of the syncline in its upper end, but lower down it crosses some of the beds. The deposits lie in a basin in the schists, upon which they rest unconformably on both limbs of the basin, the dips of the coal beds ranging from vertical in a few places to horizontal at the bottom of the trough. Near the east end

of the coal basin Healy Creek flows for more than a mile in the trough of a coal bed which forms the banks of the stream on both sides. The folded coal beds have suffered vigorous erosion both by streams and by glacial ice and in upper Healy Creek much of the series has been removed. A measured section about 6 miles above the mouth of the stream shows a thickness of about 1,500 feet of these beds, and here the upper part of the series is missing. Near the mouth of the stream a carefully measured section gave over 1,900 feet of the coal series, with about 2,000 feet of the overlying gravels. The coal series may or may not be complete at this point. At the two places where measurements could best be made the total thickness of coal found was, in the section near the mouth of the creek, 230 feet in 23 beds, of which seven beds contain 174 feet of coal. A section 6 miles east of the above showed 130 feet of coal, of which four beds contain 80 feet. As some beds of coal have been burned out in almost all sections examined, the above measurements probably fall short of the original thickness.

Lignite Creek.—The Lignite Creek coal basin is separated from that of upper Healy Creek by a high schist ridge, but the two fields are probably continuous at these lower ends. It extends eastward beyond the head of Lignite Creek and includes areas at the headwaters of Totatlanika and Tatlanika creeks. In its eastern end exposures are few and poor, as the streams have made only shallow cuts into the beds, but sufficient outcrops of coal were seen to place most of the basin among the known coal-bearing areas. By far the best exposures are to be found in the valley of Lignite Creek and its tributaries, which have cut sharp, steep-sided valleys as much as 1,000 feet into the coal-bearing beds, without, however, anywhere exposing the underlying schist in the center of the valley, so that the lower part of the series is not shown. The beds, like those in Healy Creek valley, lie in a basin bordered by schist ridges and old intrusive rocks, the beds dipping away from either border toward the center of the valley. Although at some points along the borders the dips are high, being as much as 45° on the south side of Jumbo Dome, in general the coals of Lignite Creek lie much flatter than those of Healy Creek, and through most of the valley they appear to the eye to be horizontal. The beds consist of cross-bedded sands, soft blue shales, some fine, loosely cemented conglomerates and gravel beds, and coal. In the deeper exposures the coal is hard and dense and the beds are heavy, but toward the upper beds the coals become woody and fibrous, with much shaly material, and the beds become successively thinner. As the coal series of lower Healy and Lignite creeks is overlain by a thick deposit of gravels, its actual areal distribution is much greater than is shown by a map of its surface occurrence.

A section of the coal series measured by L. M. Prindle, about 6 miles above the mouth of Lignite Creek, gives 129 feet of coal in a total thickness of 726 feet of beds. Of this more than 100 feet occurs in beds 8 feet or more thick. Another, about 2 miles farther upstream, shows 48 feet of coal in a section 170 feet high. These two exposures show only part of the whole series, and the total thickness of coal in the complete section is doubtless much greater than that of either.

California Creek.—California Creek heads on the south side of Jumbo Dome, in the Lignite Creek coal field. North of this dome it flows through another area underlain by the coal-bearing series, which crops at the surface over about 15 square miles. The beds here have the same structural relations as elsewhere, lying in a basin bordered by schist ridges and dipping toward the center of the basin. The dips, however, are gentle, and through much of the field the beds are nearly horizontal or lie in gentle wavelike swells. The streams have nowhere made deep cuts through the coal series, and the thickness seen is probably much less than the actual thickness, as there may be many coal beds below, no surface outcrops of which were seen. The extent of the field is also greater than the surface distribution, for along its western edge the coal beds are overlain by a heavy deposit of gravels. They are composed of sands, shales, and white kaolinic materials containing quartz fragments and pebbles, and beds of lignitic coal. Along the main stream for several miles a heavy coal bed 12 feet thick shows in the stream bluffs, in places dipping below the stream bars but in general lying nearly flat. Other croppings of the same or a similar bed show in tributary valleys to the east, so that it is probable that the field contains at least 12 feet, and probably more, of coal throughout its area.

In the basin at the lower end of California and Rex creeks the beds of the coal series cover an area of about 20 square miles. In character they are similar to those on upper California Creek and are conspicuous for the prominent white bluffs exposed along Rex Creek and for a bright-red color in many places where the coal has burned out and baked the adjacent beds. Some woody coal was seen on a small tributary south of Rex Creek, but no workable coal beds are known in this basin.

Tatlanika basin.—On the east side of the Tatlanika Valley, in lower Grubstake Creek and between Roosevelt and Hearst creeks, the clays, sands, and coal beds of the coal series outcrop, and it is reported that similar beds occur as far north as the head of the lower canyon of the Tatlanika. Little is known of the amount of coal present, although a bed 12 or 15 feet thick is said to outcrop at the surface, dipping at a low angle to the east. No development of the coal has been attempted here, but its occurrence is of interest,

as it affords strong additional evidence that the area of high gravels is underlain by coal between Tatlanika and Wood rivers.

Wood River basin.—In the valley of Mystic Creek and westward to that of Moose Creek the coal-bearing beds have an area of about 7 square miles. One section shows 30 feet of coal in two beds, and at another point the upper 10 feet of a coal bed outcrops. The coal has here been used for cooking and heating in a camp of 25 men, with very satisfactory results. The total thickness of the series and of the contained coal beds is nowhere exposed.

At the head of Coal Creek, which joins Wood River 4 miles below the mouth of Mystic Creek, the coal series is exposed, dipping steeply from the schist ridge to pass beneath the high gravels north of Coal Creek. No opportunity was had to study this section closely, but some 16 coal beds were seen, the aggregate thickness of which will reach more than 100 feet. In the uplift and crumpling of the beds the coals may have been given a greater thickness here than they possess farther to the north, but unquestionably there is a valuable coal field beneath the high gravels, concerning the extent of which we know little.

Dry Creek basin.—In the valley of Dry Creek, at the mouth of Newman Creek, 140 feet of the coal series is exposed beneath the high gravels. Coal beds at this place have been on fire for at least five years and are still burning. Prospect holes and coal croppings, while giving little information in regard to the thickness of the coal beds, show that the series with workable coal beds lies beneath the high gravels on Dry Creek.

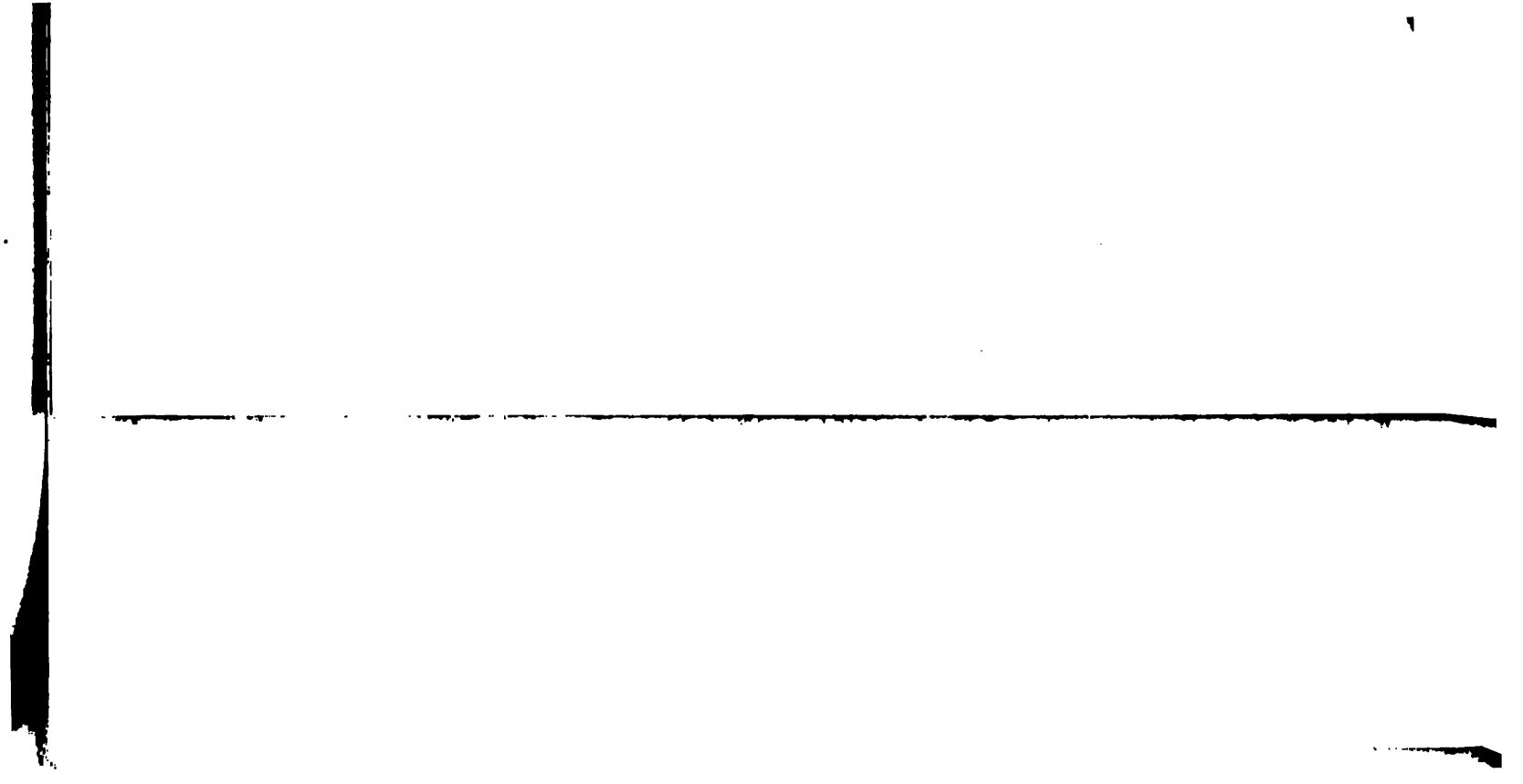
Isolated coal croppings in the basins of Little Delta River and Delta Creek also indicate that the coal is widely distributed and may underlie large areas of the high gravels as far east as Delta River.

GOLD PLACER MINING DEVELOPMENTS IN THE INNOKO-IDITAROD REGION.

By A. G. MADDREN.

INTRODUCTION.

Although several of the pioneer American prospectors of interior Alaska are known to have entered and passed through parts of the Kuskokwim Valley as early as 1889, and others are said to have visited the Innoko Valley as early as 1898, placer gold in paying quantities was not discovered in this part of Alaska until 1906. In the summer of that year gold was found on Ganes Creek, one of the principal headwaters of Innoko River, and since then a placer camp, with an average population of 150 working miners, has been maintained in the upper part of the Innoko Valley. (See map, Pl. XI.) A settlement named Ophir, situated on the main river at the mouth of Ophir Creek, has been the center of this community since the spring of 1908. The Innoko district, in spite of many discouraging circumstances, due chiefly to its isolation and difficulty of access, has established itself as a worthy producer, and from 1908 to 1910, inclusive, its placer-gold output has totaled about $750,000. This has served to stimulate interest in the gold-bearing possibilities of the streams which drain either side of the Kuskokwim Mountains and flow into Yukon and Kuskokwim rivers. Up to the present time, however, the Innoko district has suffered from a chronic scarcity of both provisions and mining equipment, and in consequence of the high costs that have prevailed very few persons have felt justified in expending much time or money in prospecting the outlying parts of the district. The result is that after three years very little is yet known about the gold-bearing possibilities of a wide extent of country that is drained by the northeastern headwaters of the Innoko and the tributaries of Nowitna and Kuskokwim rivers adjacent thereto. Prospects of placer gold are reported to occur upon the headwaters of the Nowitna, a tributary to the Yukon that lies northeastward from the northeastern headwaters of the Innoko, and upon the Tuentna or Nixon Fork, the large northeastern branch of the Takotna, situated east of the upper Innoko, but no productive



mining has been developed within these basins to date—in fact, no genuine prospecting has been done within them, although considerable wholesale locating of ground, especially in the Tuentna Valley, has been done by a few speculative individuals using powers of attorney in the unrestricted manner now practiced in Alaska.

Prospects of gold also occur on small streams that drain the northeast end of the Kaiyuh Mountains, which bound the west side of the Nowitna Valley. Several thousand dollars' worth of gold has been mined from a short gulch stream named Reeley Creek, tributary to the Yukon, opposite the mouth of Melozitna River.

Southwestward from the Innoko district more has been accomplished than toward the north and east. Some prospecting has been carried on at intervals since 1907 on eastern tributaries of Tolstoi Creek, a large branch of Dishna River, and it is said that fine colors of gold are so widely distributed within the deposits of the valleys of Madison and Mastodon creeks that prospects may be obtained at a number of places. So far, however, no concentrations of gold of sufficient worth to pay to mine have been found on any of the tributaries of Tolstoi Creek.

Since 1908 a little prospecting and a great deal of locating have been done along both the northwest and southeast flanks of the Kuskokwim Mountains where they separate the headwaters of the Dishna and Iditarod, tributaries of the Innoko, from those of Takotna, Black, and George rivers, tributaries of the Kuskokwim. (See map, Pl. XI.) During the winter of 1909–10 colors of gold were found on Deadwood Creek, a headwater of the southwest fork of the Dishna, and some open-cut pick and shovel work was done there in the spring of 1910 by several men but was soon discontinued because it did not prove profitable under present conditions. Extensive locations for placer mining have been made in this vicinity on Deadwood, St. Patrick, and other creeks tributary to the southwest fork of the Dishna and also across the divide at their heads to the south on July, Willow, and Moore creeks, which are headwaters of Takotna River, a tributary of the Kuskokwim. Very little work has been done on these locations—in fact, on most of them none at all. Moore Creek is the only one upon which gold in paying quantities has been found to date, but no production to speak of had been made there up to 1910. This general locality, however, appears to be worthy of careful prospecting.

In the later part of the summer of 1908 two prospectors, W. A. Dikeman and John Beaton, who had been to the Innoko district earlier in that year but were not encouraged by the outlook there, descended the Innoko in a small steamboat. Upon reaching the large southwestern branch of the Innoko, now named the Iditarod, these two men decided to explore that stream and prospect on its

headwaters. They ascended the Iditarod as far as the low stage of water of that season would permit their boat to go and there prepared for winter by building a log house which has since been called "Discoverers' Cabin." This house is situated on the main river about 8 or 9 miles below the present town of Iditarod, or some 25 miles below the mouth of Otter Creek. During the early winter they sledded a prospecting outfit southward from their winter quarters across several low ranges of hills to Otter Creek and decided to look for gold in the valley of that stream at a point about 12 miles above its mouth. Their choice of a location to prospect, decided upon at haphazard, as it was in midwinter, proved most fortunate, for they were rewarded by finding gold at a depth of only about 12 feet in the first holes they dug to bedrock, the discovery being made on Christmas day, 1908. The discoverers then located a moderate number of claims for about a mile along Otter Creek for themselves and a few friends.

Owing to the distance of Otter Creek from settlements or routes of travel and to the fact that the discoverers were practically alone, information about the newly found prospects of gold did not spread rapidly. It was not until the summer of 1909 that other prospectors gathered there from the Innoko and Yukon districts. The result of their arrival was the locating of claims that covered practically all the valley lands of Otter Creek, its tributaries, and the adjacent streams. Almost no mining was done during the summer of 1909 because of the lack of equipment and supplies. During the later part of this summer most of the several hundred people on the Iditarod were chiefly concerned with getting enough supplies at hand to enable them to remain through the coming winter. Considerable amounts of supplies that were shipped to the new district did not arrive because Iditarod River was at a low stage during the open season of 1909 and navigation was closed by ice earlier than usual that autumn.

In spite of these handicaps some systematic prospecting of the claims on Otter Creek was undertaken during the winter of 1909–10 and some gold was mined from small underground drifts. The reports about this work were either sent out in such optimistic form or became so magnified in transmission that a great deal of interest was aroused about the new district, with the result that when navigation opened on the Yukon in May, 1910, a couple of thousand people and a considerable amount of supplies and machinery were bound for the Iditarod. Until the middle of July the traffic to the new camp taxed the capacity of the available steamboat transportation on the Yukon and for a time the movement threatened to reach the proportions of a so-called stampede. The total gold production of the Innoko and Iditarod districts in 1910 is estimated to have a value of $825,000.

GEOGRAPHY.

When gold was discovered on Otter Creek in 1908 all of the Innoko basin constituted a subdivision known as the Innoko precinct and was included in the second judicial division of Alaska, whose court offices are at Nome. This precinct, with its recording office at Ophir, was bounded and described as follows:

> Beginning at a point on the eastern bank of the Yukon River, about 50 miles above the village of Anvik and opposite the divide between the Innoko and Yukon rivers; thence following the divide northeasterly to the divide between the Innoko and the Nowi rivers; thence in an easterly direction or southeasterly direction following the divide between the Innoko and the Nowi rivers to a point on the divide between the Innoko and Kuskokwim rivers; thence in a southwesterly direction following the divide between the Innoko and Kuskokwim rivers to the western bank of the Yukon River at a point south of Holy Cross, this last-mentioned line being identical with a part of the northern boundary line of the Kuskokwim precinct; thence northerly along the western bank of the Yukon to the place of beginning.

An act of Congress taking effect July 1, 1909, resubdivided Alaska into four judicial divisions instead of three and placed the original Innoko precinct in the fourth division under the court at Fairbanks. A new adjustment of several precincts was made necessary by this redivision and to facilitate recording matters the Innoko precinct as formerly defined was divided into two precincts, the recording office at Ophir being retained to accommodate the miners in the eastern headwater portion of the Innoko Valley, and a new precinct named Otter being formed to include the Iditarod placer-gold district or western part of the Innoko basin. The recording office for the Otter precinct is at the town of Iditarod.

The Iditarod gold-placer district is situated along the upper valley of Iditarod River, about 65 miles east of the settlement of Holy Cross or Koserefski, on the lower Yukon. (See map, Pl. XI.) Iditarod River is the largest branch of Innoko River, which is the largest eastern tributary of the lower Yukon. The Innoko joins the Yukon about 300 miles from Bering Sea. It flows into the Yukon through two or more divergent and crooked channels in which the currents are so sluggish that they are generally called sloughs. The channel most frequently used by the steamboats that ply the Innoko and Iditarod enters the Yukon a few miles below and opposite Holy Cross. This channel may be considered the mouth of the Innoko. The lower 150 miles of the Innoko is commonly but incorrectly called Shageluk Slough, owing to the fact that a side channel of the Yukon flows into the Innoko at that distance above its mouth. This channel, which is about 35 miles long and navigable for steamboats, leaves the main Yukon about 80 or 90 miles above Holy Cross. It delivers a considerable amount of Yukon water to the Innoko and is of considerable consequence in increasing the volume of the lower 150 miles of that river, but the Innoko proper furnishes by far the largest

amount, and although many persons consider the mouth of Innoko River to be at the confluence of Shageluk Slough with the Innoko and name the lower 150 miles of the Innoko channel Shageluk Slough also, this designation should be restricted to the side channel that carries Yukon water exclusively.

The main Innoko River is about 500 miles long and with its tributaries drains the largest part of an extensive area that lies between the central lower courses of Yukon and Kuskokwim rivers. Its principal or northeastern headwaters, upon which the Innoko placers are situated, lie between the Kaiyuh Mountains on the northwest and the Kuskokwim Mountains on the southeast, these ranges separating its upper valley from the drainage of Yukon and Kuskokwim rivers, respectively.

The southern portion of the Innoko basin is drained by Iditarod River and its tributaries. The chief or eastern headwaters of this stream rise along the divide of the Kuskokwim Mountains about 75 miles east of Holy Cross and drain an extensive area that lies along the northwestern slopes of these mountains. Iditarod River flows into Innoko River about 45 miles above Shageluk Slough, or 200 miles from Holy Cross by the regular steamboat route. In direct distance its source is not more than 100 miles south of its mouth, but the total length of the actual course of the Iditarod is probably 300 miles, as it has an extremely meandering channel, especially throughout its lower portion, for both the Innoko and Iditarod meander widely for many miles through sluggish channels across swampy plains that occupy the lower half of the Innoko Valley. During the spring freshets the whole lower valleys of these rivers are inundated, and after the floods have subsided large areas of swamps, shallow ponds, and lakes remain over its surface.

Iditarod River drains a considerable area on the southeastern side of lower Yukon Valley along its southeastern boundary, the Kuskokwim Mountains. The upper 100 miles of its course is along the northwestern foothills of these mountains and the river receives its chief headwater tributaries from them. Broadly considered the Iditarod district comprises an area of about 500 square miles that is drained by several of the larger eastern tributaries of this river. In upstream order these tributaries are named Caribou, Otter, and Bonanza creeks. Extensive locations for placer mining have been made throughout the valleys of these streams, but the area within which actual discoveries of placer gold have been made and mining operations undertaken is much smaller and may be included within a tract 10 miles square. Practically all the productive placer ground now known lies within the valley of Otter Creek and about the sources of several small streams just south of Flat Creek, which is the most important gold-bearing tributary of Otter Creek.

TRANSPORTATION, SETTLEMENTS, AND POPULATION.

The only practical way of transporting supplies to this district is by means of shallow-draft stern-wheel river steamboats plying Yukon, Innoko, and Iditarod rivers. During 1910 most of the freight was brought up the Yukon to Holy Cross on large steamboats and there transferred to smaller ones which ascended the Innoko and Iditarod to the supply points that have been established at several places along its course. Considerable freight, consisting largely of mining machinery, was also brought down the Yukon from Fairbanks and taken to the new district by way of Shageluk Slough and Innoko and Iditarod rivers.

During the stages of high water that prevail in these rivers in June and sometimes at other periods during the summer months steamboats of moderate size are able to ascend the Iditarod as far as the mouth of Otter Creek, a distance of about 216 miles above its mouth. During the average summer stages of water, however, the moderate-sized steamboats can not ascend the Iditarod so far, and the upper settlements can be reached only by much smaller steamboats and launches. This variable condition of the navigability of the river has determined the location of the supply settlements on the Iditarod.

At present there are three such settlements of importance on Iditarod River. These, in down-river order, are named Otter, at the mouth of the stream of that name, which is about 216 miles above the mouth of the river; Iditarod, situated about 16 miles by the course of the river below Otter; and Dikeman, which in air-line distance is only 29 miles but by the river 70 miles below Iditarod. Dikeman is about 130 miles up the Iditarod from its mouth, or 330 miles from Holy Cross by the steamboat route, and the town of Iditarod is about 400 miles from Holy Cross.

Dikeman is situated on the east bank of Iditarod River where it leaves the low foothills that border its upper course. The river from Dikeman to the Innoko flows sluggishly 130 miles by a very tortuous channel across the swampy plains of its lower valley. Its channel is deep enough at all stages of water for moderate-sized Yukon steamboats to ascend to Dikeman, and this point is considered the head of low-water navigation. Dikeman has been established as a storage and transfer point for freight and passengers to the placer district, and several of the larger commercial companies have built substantial warehouses and stores here for that purpose. Its population in 1910 numbered about 100 persons.

The town of Iditarod, with a population of 600 or 700 persons, has been, since its establishment in June, 1910, the commercial center of the district. It is situated on the east side of the river, 70 miles above Dikeman by the summer water route, or 31 miles by a winter sled trail recently laid out by the Alaska Road Commission. The

town site is on a rather unfavorable frozen boggy bank, whose only local advantage for the purpose of settlement seems to be that it stands high enough to be above the waters of spring freshets. A number of substantial warehouses and business buildings have been erected there, and all the activities of a boom town were much in evidence during the summer of 1910.

This town is 8 to 12 miles from the mines by an overland route that is too boggy in its present condition to be of much service for hauling supplies to the mining camps with horses and wagons. Although this method of transportation was carried on during the summer of 1910 it was accomplished with great difficulty and expense, and unless a good road is built this overland route can not compete with the water route by way of the river and Otter Creek.

The settlement of Otter, at the mouth of Otter Creek, is an important point for the distribution of supplies to the mines, as steamboats can reach this place at times of high water and from it freight can be transported up Otter Creek to the diggings by means of scows towed by horses. The distances from the mouth of Otter Creek to the mining settlements on that stream are from 16 to 20 miles by the water route or from 8 to 10 miles by land.

The most important mining settlement is named Flat. It is located on the east bank of Otter Creek about 16 miles above its confluence with the Iditarod just below the mouth of Flat Creek, which is the most important tributary of Otter Creek bearing placer gold. About 2 miles above Flat, on the west side of Otter Creek, is a place named Bowlder, and from 1 to 2 miles farther up Otter Creek, on the same side of the main stream, is a straggling settlement called Discovery because it is located at the mining claim so designated.

In 1910 the population of Otter numbered about 50, and Flat and Flat Creek probably had a population of 400. Bowlder, Discovery, and the near-by claims along Otter Creek had about 300 residents. During 1910 there was also a floating population of about 1,000 men in the district, who were temporarily camped at different places along the river and creeks. In August and September about 500 of these men were busy locating placer claims on tributaries of the Kuskokwim opposite those of the Iditarod to the south. It is estimated that on an average 2,500 people were in the Iditarod region during the summer of 1910.

Supplies are transported to the Innoko district by taking them up Innoko River on medium-sized Yukon steamboats as far as Dishkakat, which, like Dikeman, on the Iditarod, is considered the head of ordinary low-water navigation for such craft. At times of high water smaller steamboats may ascend the Innoko about 100 miles above Dishkakat to the vicinity of the North Fork, some 90 miles below

Ophir. From the North Fork the freight is carried to Ophir in lots of 4 to 6 tons on light-draft scows towed by horses.

A considerable amount of supplies for the Innoko placer district is now being brought up Kuskokwim and Takotna rivers to a settlement called Takotna Station, which is about 20 miles from Ophir by a winter sled trail that crosses a low divide between the Innoko and Takotna drainage. The Kuskokwim route appears to be the best way to supply the Innoko placer district.

GEOLOGIC SKETCH.

The Kuskokwim Mountains form a divide from 2,000 to 4,000 feet above sea level between the drainage of Innoko and Iditarod rivers and that of the central part of the Kuskokwim Valley. The hard-rock formations of the region are fairly well exposed along the crest of this range and the secondary ridges which separate the streams that flow therefrom. These mountains appear to be mostly made up of a widespread series of sedimentary formations largely of Mesozoic age, with which are intimately associated considerable amounts of volcanic rocks of various kinds, some of which, at least, are older than a large part of the sedimentary formations, because fragmental detrital materials derived from the volcanic rocks are commonly interbedded with the sediments as tuffs.

The sedimentary rocks of the Kuskokwim Mountains are a series of alternating beds of sandstones, carbonaceous and calcareous shales, shaly and siliceous limestones, granitic arkoses, volcanic tuffs, and conglomerates. The sandstones are generally rather thinly bedded and flaggy. The shales range from soft to fairly hard rocks and in the Innoko district appear to be partly altered to slates. Near their contacts with granitic intrusives they have been locally hardened into blocky quartzites and argillites.

The general structural trend of the sedimentary series is northeast and southwest, with southeasterly and northwesterly dips at angles varying from 20° to 80°.

The volcanic rocks of these mountains are more or less altered rocks of basaltic types. They all have a general greenish color such as naturally belongs to ancient and somewhat altered lavas that are considerably decomposed. Closely associated with these volcanic rocks in many places occur large amounts of more or less consolidated fragmental igneous material which appears to be directly derived from the volcanic rocks and so may be classed as tuff. These beds of tuffs in places appear to change laterally into shales and sandstones of undoubted sedimentary origin, or to be at least interbedded with such rocks. The definite relations of the sedimentary formations to one another and to the volcanic rocks have

not been determined, and so far as the evidence goes they may be provisionally considered as essentially contemporaneous in origin, their differences being accounted for by variations in local conditions. It may be noted, however, that the volcanic and intrusive igneous formations appear to be most extensively developed along the main divide of the Kuskokwim Mountains and that the sedimentary formations of these mountains become more free from mixture with either volcanic or intrusive rocks along both their outlying northwestern and southeastern flanks as they recede from the backbone of the range. These probable relations seem to indicate that the volcanic rocks and closely associated tuffs and sediments which lie along the center of the Kuskokwim Mountains may be older than the outlying sedimentary formations that make up the mountain flanks, and the presence of arkose sandstones, apparently derived from granitic rocks, in these flanking formations seems to indicate that the granitic masses distributed along the mountains, which may be the source of the arkose sandstones, are older than at least a part of the outlying formations. The few fragmentary fossil remains of land plants and marine-shell forms that have so far been found in these sediments point to an undoubted Mesozoic age for the series and a probable Cretaceous age for its younger members, of which the arkose sandstones appear to form a part. This meager evidence indicates that a large part of the granitic intrusive rocks are of early or pre-Cretaceous age; at any rate the older sedimentary and closely associated volcanic formations appear to have been the country rock which the intrusives penetrated.

Most of the highest areas throughout this general region are made up largely of mountainous masses of these intrusive granitic rocks. Dikelike bodies of these siliceous intrusives trend in different directions, but mostly northeastward and southwestward, across the intervening areas of sedimentary rocks in a manner that vaguely suggests that there may be a more or less connected network of intrusive dikelike bodies extending between the large intrusive centers. The dikes are ordinarily of siliceous varieties, such as biotite granites and hornblende diorites, sometimes porphyritic, although some are more basic, such as diabase porphyry and basalt. It is possible that these more basic dikes may belong to an earlier period of intrusion and be more closely connected with the volcanic flow rocks.

The sedimentary rocks are generally more or less metamorphosed near the intrusives, the degree of alteration becoming progressively less with distance from the contacts. The contact metamorphism that has occurred along these intrusives appears to have caused the conditions that have brought about, in places at least, the mineralization along the contact zones from which the placer gold has been derived.

The rocks of the Kuskokwim Mountains do not, in general, contain well-marked veins, but in the vicinity of some of the siliceous dikes the country rocks are altered, chiefly by silicification, at some places for only a few feet from the contact but at others for considerable distances, and there occur narrow vein deposits near the contacts of dikes with stratified rocks, and locally small gash veins within the dikes themselves. The material of these veins is generally quartz but in places calcite. The metallic minerals associated with these veinlets and zones of alteration are sulphides, of which iron pyrite, chalcopyrite, galena, and cinnabar are the most common kinds. Some of these minerals are presumed to be gold bearing because the placer gold is evidently derived from the decomposition and erosion of these mineralized contact zones.

OCCURRENCE AND DISTRIBUTION OF THE PLACER GOLD.

ORIGIN OF THE PLACERS.

The placer-gold deposits of the Iditarod district appear to be of distinctly local origin. As now developed, the commercially important stream concentrations of gold are small in extent and their distribution is evidently very closely dependent upon the apparent bedrock origin of the gold. The origin of the placer gold appears to be closely connected with the mineralization that has taken place locally along the contacts of siliceous intrusive rocks with the more basic igneous rocks and the sedimentary formations. For example, in the valley of Otter Creek the placer gold is found in very close association with bodies of granitic intrusive rock. Here two bodies of granite seem to be present, one lying across the valley of Otter Creek just below Granite Gulch and the other on the head of Flat Creek, a tributary on the south side of Otter Creek. These granitic masses have a width of at least half a mile and a length of 1 to 3 miles. Their longest dimensions have a northeasterly and southwesterly direction in conformity with the general structural trend of the sedimentary formations; they are in line with each other along this trend and may be connected, although this is not known to be the case.

In the Innoko district the direct local derivation of the placer gold from zones of contact mineralization is not so evident as it is in the Iditarod. There are no large intrusive bodies very near the Innoko placers, and the gold seems to be distributed farther from an apparent bedrock source. There are, however, some siliceous dikes cutting the country rocks within the valleys of the placer streams. Some of these dikes are known to be mineralized with pyrite, and it may be presumed there are more of them so mineralized. Vein quartz occurs along the walls of some of the dikes, and some of this quartz

is known to contain gold. Thus it appears that the placer gold is relatively local in origin and distribution.

INNOKO GOLD-PLACER DISTRICT.

An account of the Innoko district has already been published [1] in which a general description of this region has been given and its mining development up to 1908 outlined. Therefore only a brief review and summary of the progress of mining development up to 1910 is given here.

Practically all the mining in this district has been performed within the valleys of Ophir, Spruce, Little, Ganes, and Yankee creeks. The placer gold occurs in creek, bench, and gulch deposits. Various methods of mining have been practiced according to the position and character of the deposits; sinking and drifting, groundsluicing and open cut, scraping and hoisting by steam power, shoveling and hoisting by hand, and canvas-hose hydraulicking have all been used in different combinations upon the different creeks.

GANES CREEK.

Placer gold was first mined in the Innoko district on Ganes Creek in 1907, near the place where it was discovered the previous summer. It soon became apparent to those interested in claims on this stream that the gold-bearing deposits which could be mined most profitably were not those in the present stream bed, but older gravels which rest on bedrock benches that now stand from 30 to 60 feet above the level of Ganes Creek. These benches, which are remnants of an older valley floor, are situated for the most part on the east side of the creek about 7 miles above its mouth. They are from 100 to 500 or 600 feet wide and extend along the valley for several miles, with interruptions at intervals caused by gulches that have been cut down through them by nine short tributary streams. These bench gravels have been mined each summer since 1907 at the most favorable places by half a dozen or more parties, each composed of about three to six men. The mining operations have not been conducted upon an extensive scale because enough water can not be obtained from the short gulch streams that rise along the eastern side of the valley behind and above the benches for effective hydraulicking with a large plant, and because the capital with which to purchase and install the equipment of such a plant has been beyond the moderate resources of the men who are interested in the ground. The result is that all the mining has been conducted upon selected areas of small extent in as simple and inexpensive a manner as possible. A cover of muck and silt is sluiced off with streams of water led upon

[1] Bull. U. S. Geol. Survey No. 410, 1910.

the benches from small ditches that have been dug up the short gulch tributaries. The supply of water obtainable from these gulches varies much from year to year and even from week to week during the same summer; consequently the amount of mining that may be accomplished during a given season is always uncertain. On some of the bench claims enough water for the mines can be obtained only during the spring thaw and after uncertain rains. During dry summers all mining operations on the Ganes benches are greatly handicapped by scarcity of water.

After the overburden, which varies from 2 to 12 feet in thickness, has been removed the pay gravels, which are from 1 to 6 feet thick, are shoveled into lines of sluice boxes arranged to carry the tailings over the edge of the bench or dump them into gulches cut below the level of the bench—whichever is the more convenient. From 6 inches to 3 feet of splintered and flaky slatelike bedrock which contains gold is also shoveled into the sluice boxes. Considerable areas of these bench deposits that may be worked by these methods still remain, but a large part of the most favorable ground has been mined.

Several drift-mining operations of slight extent have been conducted along the base of the rock bluffs upon which the gold-bearing gravels rest, and from this source some gold has been obtained. There seems to be no doubt that the gold found in the lower-level gravels along the base of the bluffs that form the benches and in the present bed of Ganes Valley has been derived from the deposits on top of the benches.

The total gold production of the Ganes Creek placers up to the present time is estimated to be about $150,000.

LITTLE CREEK.

Little Creek lies northwest of and parallel to the lower part of Ganes Creek, which it joins about half a mile above the Innoko. It is approximately 7 miles long and is separated from Ganes Creek by a ridge about 2 miles wide and 600 feet high.

Gold was discovered on this stream during the summer of 1907 and mining has been conducted since 1908 on claims that occupy the middle 3 miles of its valley bottom. The unconsolidated deposits vary from 10 to 25 feet in depth. In some places they are frozen and in others thawed. They consist largely of mucks and silts, with a small quantity of gravel. In some localities gravel beds 2 to 4 feet thick rest on the bedrock beneath the silts, but in many places the silts lie directly on the bedrock and gravels are practically absent. The bedrock of Little Creek is a hardened shale or argillite that varies in texture from gritty to fine grained. In places it has slaty cleavage, but most of it is massive. Its upper 10 feet is generally very much shattered. It breaks into blocky slabs and shingle fragments and

also into roughly columnar 4-sided to 7-sided forms from 2 to 4 inches in diameter and from 10 to 18 inches in length. Many of these columnar pieces stand on end in the weathered bedrock, and where gold is present the best concentrations are generally found in this kind of bedrock, which acts as natural riffle blocks. From 2 to 10 feet of the upper part of the bedrock is generally thoroughly shattered in this blocky or slabby manner and the fragments are commonly separated, the spaces between them varying from one-tenth to 1 inch or more in width. These spaces are filled to a depth of 2 to 6 feet with sediment or silt, which appears to have filtered down from above. Most of the placer gold, which consists of flaky, fresh rough pieces of small size, occurs in these sediment-filled spaces in the bedrock, where it appears to have become concentrated along with the sediments that fill the interspaces. From 2 to 6 feet of the shattered bedrock is dug up in mining, and most of the gold output is obtained therefrom.

The Little Creek placers have been mined both by surface open-cut groundsluicing and underground sinking and drifting methods, the practice adopted depending upon the position, depth, and condition of the deposits. Along the valley bottom, where the deposits are deepest and contain more or less perpetual frost, considerable sinking and drifting work has been done; but this has proved profitable only where the gold happens to be concentrated in quantities above the average. Such concentrations appear to be distributed in disconnected strips and spots along the bedrock floor of the valley, but they are of uncertain extent and difficult to trace. As soon as drifts are extended beyond the limits of the richer concentrations or into thawed deposits, the underground work generally becomes unprofitable. Though it may be continued for some distance in the hope of finding other rich places, such work is more of the uncertain nature of prospecting than the mining of ground known to contain fairly uniform paying values, such as are essential to success, especially in a district like the Innoko, where all mining operations are expensive.

Underground mining would probably not be undertaken at all in the Innoko district if it were not for the lack of water in sufficient quantity for hydraulic mining and of sufficient grade to the valleys to afford dumping space for tailings. None of the workings on Little Creek is more than 30 feet deep, and if enough water could be readily obtained in this valley no doubt all its gold-bearing deposits might be cheaply mined by hydraulic methods if the tailings were elevated. But this stream is so small that the average supply of water is barely sufficient for ordinary sluicing operations, especially during summers of little rainfall. By taking advantage of the more abundant flow of water during the spring thaw and at uncertain times of heavy rainfall, surface open-cut mining has been carried on to a moderate extent at several places, both in the present creek channel and upon

either side of the stream. The deposits along either side of the present stream are termed "benches" by the miners; but they are not distinct terraces, such as occur along Ganes Creek, for on Little Creek there is no abrupt break in the vertical position of the gold-bearing deposits as there is on Ganes Creek. They rest on a fairly even bedrock surface that slopes up sufficiently from the lowest part of the valley to afford dumping space for the waste material it is necessary to remove in order to lay bare the gold-bearing bedrock that occurs on either side of the stream at some places. Practically all of the waste overburden consists of silts, clays, and vegetable muck, which varies from 3 to 10 feet in thickness. There is little or no gravel present and cobbles or bowlders are not plentiful.

The waste overburden is removed in the usual manner by ground-sluicing or washing it away with streams of water led upon it from small ditches that have been dug along the valley slopes above. After the bedrock in these open cuts has been laid bare, from 2 to 4 feet of the upper shattered part is loosened with picks and washed through lines of sluice boxes to recover the gold that is lodged in the sediment that fills its crevices.

An average of six to eight outfits have mined along Little Creek since 1908. The open-cut work can be done only during the season of flowing water and then only at the times of maximum flow, which are generally in the early part of the summer. The drift mining may be carried on more or less throughout the year.

Some of the open-cut mining has produced as much as $1 to the square foot of bedrock surface, but most of it yields less than this. In the underground drifts, as in the open cuts, about 4 feet of shattered bedrock is dug up and washed for gold, and good ground will yield $1.50 to the cubic yard, but the additional cost of steam thawing, of the labor to hoist the loaded buckets from the shaft by hand windlasses, and of the unproductive work performed in extending the drifts through ground that contains little or no gold reduces the profits of work of this kind. The total production of gold from Little Creek since 1908 probably amounts to about $150,000.

SPRUCE CREEK.

Spruce Creek is northwest of and parallel to Little Creek, being separated from it by a ridge about 2 miles wide and some 800 or 900 feet high. Its valley is about 6 miles long and is similar to that of Little Creek. The country rock within it is likewise the same hard blocky shale or argillite. The creek appears to carry a little more water than Little Creek but still not enough to permit very satisfactory hydraulic operations.

The alluvial lands along this valley have been located for placer mining since 1908, and although some prospecting has been done at several places along the stream from time to time nothing was

discovered that led to productive mining within its basin until the autumn of 1909, when good prospects were found on a low bench situated about 3 miles up the valley on its eastern side, about 200 yards from the present course of the stream. At this locality the creek now flows along the base of a steep bedrock slope that forms the western side of the valley, and the gold-bearing area extends eastward from it, the bedrock floor of the valley rising some 30 or 40 feet in this direction within a distance of about 500 feet. This sloping valley floor is covered by 5 to 15 feet of clay, silt, and muck, the greater part of which is frozen. The eastern rise of both the bedrock across the valley and the surface of its overburden make it practicable to groundsluice the waste mantle aside into the creek in the same manner as on Little Creek. As the supply of water obtainable from Spruce Creek is somewhat more abundant than that of Little Creek, the groundsluicing open-cut work may be carried on more continuously throughout the summer. The claims that are being mined receive water from above, brought by a ditch about 9,000 feet long that has been dug along the eastern side of the valley, so as to deliver water about 50 feet above the creek at its lower end, where it is led upon the sloping bench through canvas hose and the gold-bearing bedrock is cleared of its frozen mantle of clay and muck. The shattered bedrock, in which the gold occurs in the same manner as on Little Creek, is then loosened with picks and shoveled into lines of sluice boxes for washing.

About $20,000 worth of gold was mined from these so-called bench claims during the summer of 1910 by the open-cut groundsluicing method described above.

No productive drift mining has yet been done in this valley.

OPHIR CREEK.

Ophir Creek lies about 1½ miles northwest of and parallel to Spruce Creek. It is about the same length (6 or 7 miles) and size as Spruce Creek, and the ridge dividing them is about the same height as that between Spruce and Little creeks. In brief, all three of these valleys have very similar features of length, width, depth, direction, bedrock, and other general characteristics.

Ophir Creek differs from Spruce and Little creeks principally in that its placer gold is more abundantly and uniformly distributed along the bottom of its bedrock channel and that the valley is more evenly filled across and along its bottom with silts, clays, and muck, which for the most part are frozen and of uniform thickness. The valley filling averages 25 to 30 feet in depth. At some localities it is a few feet less than 25 feet and only in a few places more than 30 feet from the surface to bedrock. As a rule there is little gravel in the stream deposits, *but occasionally* some gravel is found on bedrock.

Most of the placer gold, as on Little and Spruce creeks, is lodged in the sediment that fills the numerous crevices in the shattered bedrock to a depth of 2 to 5 feet. The best concentration of gold, or the pay streak, varies from 20 to 70 feet in width across the rock floor, the wider distribution of gold appearing to be along the lower part of the valley. The pay streak is not always continuous or of uniform richness along the length of the valley. At some places the gold is concentrated more abundantly on one or the other side of the bedrock channel near what are called "rims," which are generally upraised portions of harder bedrock; at other places it is found somewhat restricted to small areas or patches of bedrock; but on some claims the gold is rather uniformly distributed in the shattered bedrock over considerable areas.

Although the placer-gold deposits in Ophir Valley are nowhere more than 35 feet below the surface and may be classed as comparatively shallow diggings, practically all the mining that has been performed along the creek has been done by sinking and drifting with the aid of steam thawing. Mining of this kind has been carried on continuously along Ophir Creek since 1908, in the spring of which year gold in paying quantities was first discovered in this valley. Most of the mining has been accomplished with very crude and inadequate equipment, various kinds of small boilers of the prospecting type being commonly used to generate the steam for thawing the frozen ground. Many of these boilers are of insufficient capacity for effective work. Most of the hoisting from the shafts has been done with homemade wooden hand windlasses operated by one or two men, but recently several operators have installed automatic-dumping steam-hoist equipment.

The largest part of the gold-bearing material is mined during the winter and accumulated on dump piles which are washed for their gold content at the time of the spring thaw, when water is more plentiful than at any other time of the year. The supply of water available for sluicing during ordinary summer seasons is never abundant and during dry periods is often entirely insufficient. At some places sluicing can be carried on during the summer season only after heavy rains and, as such times of increased water supply can not be predicted or depended upon, the amount of gold washing that may be accomplished during a summer is uncertain. Occasionally portions of a summer's output of gold-bearing material can not be washed until the spring after it is mined.

It is no doubt a fortunate circumstance that mining operations on Ophir Creek have not been handicapped by having the placer claims located in the objectionable form of large association groups, whereby the mining privileges to large tracts of land may be dominated by a few individuals, who generally have not the resources or initiative to mine the ground themselves and generally retard mining developments

by making unreasonable or even prohibitive demands of those who may wish to mine. All the properties on Ophir Creek are located in the form of single claims of about 20 acres or less, so the interests in mining ground are sufficiently divided to afford opportunities for independent mining to a number of individuals. There are two discovery claims on this creek, a lower and an upper. Eight claims are numbered in downstream order below Lower Discovery claim, and above this claim they are numbered upstream to "No. 12 above Lower Discovery." "No. 12 above" is the same as Upper Discovery, and upstream from this claim the numbers begin again with 1 and extend to the head of the valley.

Productive mining has been done along Ophir Creek since the summer of 1908, on nearly all the claims from "No. 4 below Lower Discovery" to "No. 4 above Upper Discovery," which cover 4 or 5 miles of the middle length of the creek. From 15 to 20 parties have been mining along the valley each year. These parties number from three to ten men each. The larger operators have frequently employed labor, but much of the mining has been done by three or four men working together on a partnership basis.

Ophir Creek has been the largest and steadiest producer in the Innoko district. The output of placer gold from it for the three years 1908 to 1910 totals about $350,000.

YANKEE CREEK.

Yankee Creek is a stream of considerable size and about 12 miles long that lies about 4 miles southeast of the lower course of Ganes Creek. Its valley trends in the same direction as that of Ganes Creek and the other three tributaries of the upper Innoko, upon which placer mining is being conducted. All five of these streams flow from the southwest toward the northeast. The general parallelism of these valleys and the ridges which divide them may be due to structural features of the sedimentary formations of the district, for these appear to extend in a general northeast-southwest direction throughout the region.

Although locations were made on Yankee Creek for placer mining in 1907, gold in paying quantities was not found in its valley until 1909. Most of the mining has been done upon parts of two large tracts located in the form of association-group claims, containing about 160 acres each, situated 6 or 7 miles above the mouth of the creek. The titles to some of this ground became a matter of litigation in court as soon as the land was learned to be of value, the questions involved being whether the first locators, who were not present when gold in paying quantities was found, had not forfeited their rights in the property by abandonment, whether they really knew there was gold on the claims when they located them, and whether they did any assessment work to show their intentions to mine the ground after they made their original

locations. The point worthy of notice is that the ground in dispute was located in the form of large association-group claims, so that the litigation involved a large area of land and thus retarded mining developments in a way that would not have occurred if the ground had been located in the form of single 20-acre claims by individuals.

The gold-bearing deposits that are being mined on Yankee Creek differ somewhat from those on Little, Spruce, and Ophir creeks in that they are more shallow, being only about 8 feet deep, and are composed largely of beds of coarse gravel from 5 to 7 feet thick, covered by only 1 to 3 feet of silt and muck. The valley bottom has a fairly broad, flat cross section and its sides have moderate slopes in most places, so the unconsolidated deposits have a uniform depth and considerable width. The stream has a good flow of water and more of a grade than the other placer creeks. The gravel deposits appear to be well drained and largely unfrozen, perhaps because the unconsolidated deposits are not deep, because there is a good circulation of water through the coarse porous gravel, and also because the silt and muck covering the gravels is comparatively thin.

The mining of these shallow placer deposits is summer open-cut work. After the deposits covering the surface are groundsluiced off for a width of about 100 feet the gravels are shoveled into wheelbarrows and then conveyed to a hoist bucket suspended from an overhead cable and elevated to a dump or rock box at the upper end of a line of sluice boxes erected on trestles. The coarser material is forked out of the rock box and the remainder washed through the riffle boxes. The general procedure is the same as that practiced on Flat Creek, in the Iditarod district (see pp. 255–258), but the operations have not been as extensive as those on Flat Creek, partly because some of the ground on Yankee Creek has been tied up by litigation, and also because there has not been an adequate supply of steam hoisting and scraping machinery available in the Innoko district. Only one steam hoisting plant was installed on Yankee Creek in 1910. The other operators were hoisting the gold-bearing gravel to the sluice boxes by hand windlasses.

Yankee Creek first became a producer in 1909, the output for that year amounting to about $15,000. During 1910 from $50,000 to $60,000 was mined. The total production for 1909–10 amounts to about $75,000.

IDITAROD GOLD-PLACER DISTRICT.

OTTER CREEK.

Otter Creek is in reality a small river whose valley has a length of about 30 miles and a width between the crests of its bounding divides of 6 to 8 miles. For the greater part of its length Otter Creek flows near the right-hand side of its valley bottom along the foot of abrupt

slopes that rise directly from the stream channel to heights of 500 to 1,500 feet within distances of 1 to 2 miles. At the scene of mining on Otter Creek the floor of the valley is about one-fourth mile wide and the placer claims practically all lie on the left side of the stream. Beyond these claims the left slopes of the valley rise gradually to the divide, 4 or 5 miles distant. The volume of water in Otter Creek is large enough to afford transportation for supplies by means of horse scows and poling boats from Iditarod River to the mines, but the grade of the valley is not sufficient to make this water available for hydraulicking the placer deposits.

The productive gold-placer ground lying along Otter Creek is of comparatively local extent when the length and size of the valley are considered. The present mining operations on this creek are confined to a limited tract of land about 2 miles long and one-fourth mile wide situated in the valley bottom about 12 miles above its mouth. Beginning at the upper limit of known productive ground, the mining claims included within this tract in downstream order are as follows:

The Gum Boot group, which consists of about 60 acres that extends across Otter Creek at the mouth of a right-hand tributary named Granite Creek, lies between claims located on the lower part of Granite Creek and the Otter Association group. The latter group, which is 1 mile long and one-fourth mile wide, extends along the center of Otter Valley Flat, with the mouth of Granite Creek about opposite the middle of its length. These two association groups have been prospected and the conclusion reached that gold in paying quantities does not occur in them above Granite Gulch.

Below Otter Association group there is a row of six single placer claims designated Nos. 2 and 1 above Discovery, Discovery claim, and Nos. 1, 2, and 3 below Discovery. Along the left side of these six claims is another line of similar claims with corresponding numbers and the additional designation "first tier of left-limit bench claims." There is also part of a second tier of left-limit bench claims and several small fractional claims. Altogether these claims cover the width of the valley flat for about 1½ miles along its length. Below No. 3 below Discovery there is a group of claims named the K. P. M. Association.

It is reported that prospects of gold are found as far down Otter Creek as the K. P. M. Association, but it is generally conceded by those who have prospected along Otter Valley that gold in productive quantities, in the sense that is now accepted in the district, does not occur below the vicinity of claim No. 2 below Discovery. Thus the general extent of the productive area on Otter Creek, as now defined, is that part of its valley floor that extends downstream from the mouth of Granite Creek for about 1½ miles. Throughout this area the country rock upon which the gold-bearing deposits rest is com-

posed largely of granitic rocks, the upper parts of which are considerably decomposed and overlain by a layer of residual sands derived from the granites. These sands grade into the solid country rock in many places and as a whole do not appear to be very much washed or sorted by running water. Mixed with them are some gravels and a considerable number of residual granite blocks, bowlders, and cobbles, which are evidently harder portions of the granite that have resisted decay and have not been moved any great distance from their original bedrock source. These deposits hold the placer gold, which also has the same residual character as the material in which it rests in that it consists mostly of sharp, rough, flaky pieces, rather than of smooth waterworn nuggets. Most of the gold occurs in the sands and decayed bedrock. Much of it has sifted down into crevices in the bedrock, where it is present in thin seams of fine sediment that fill these cracks to a depth of 3 to 6 feet. The gold also has a tendency to concentrate more abundantly upon layers of clayey sediment interbedded with the sands and gravels.

The gold-bearing placer beds vary in thickness from 1 to 6 feet. In mining them from 2 to 6 feet of the bedrock upon which the unconsolidated deposits rest is also taken up to recover the gold in its crevices. Covering these deposits is an overburden of sediment and vegetable muck from 4 to 12 feet thick. Altogether the unconsolidated materials of the placer area on Otter Creek have a total thickness of 10 to 20 feet and the placers are classed as shallow. They are in general frozen, but where mining is being done it has been found that the deposits are not frozen throughout and that considerable areas are thawed and wet. This may be caused by the presence in the valley of large quantities of flowing water. Where the gravels are thawed underground water is abundant, but as all the productive mining is done by open-cut methods the presence of flowing water and thawed ground does not hinder working them as it does in deep or underground mining.

FLAT CREEK.

Flat Creek is a southern tributary to Otter Creek, which it joins about 2½ miles below Discovery. It has its source on a wide-topped mountain mass at an elevation of about 1,600 feet above sea level and flows about true north for 5 miles. The elevation of Otter Creek at the mouth of Flat Creek is about 300 feet above sea level, but although there is a difference of about 1,300 feet between the mouth and source of Flat Creek about 1,000 feet of this difference occurs within 1 mile of its head, and the lower 4 miles of its valley has a comparatively low, even grade of about 100 feet to the mile. It is this characteristic of the valley that has suggested the name Flat. This name is also applied to the most important mining settlement

in the district, which is located on the south bank of Otter at the mouth of Flat Creek.

The head of Flat Creek valley is a semicircular, steep-sided basin whose catchment area is large in proportion to the size of the valley as a whole, and for this reason Flat Creek has a larger volume of water than is usual for so short a stream.

The body of intrusive granite previously mentioned (p. 245) as extending across the head of Flat Creek occupies practically all of the steep headwater slopes of this valley, or the upper mile of its length, but throughout the rest of the valley, or its lower 4 miles, the softer sedimentary formations of the region occur. Along the zone of contact of the granitic and sedimentary rocks considerable alteration has taken place, and mineralization appears to have occurred in both along a belt of considerable width. Quartz stringers from 6 to 12 inches thick occur in the granites, and the sandstones and shales have been hardened to quartzites and argillites or blocky slates. The hardening of the sedimentary rocks extends as far as a mile from the granite but gradually becomes less with increasing distance from the contact. This contact crosses the upper part of the valley in a diagonal northeast-southwest direction along the lower slopes of its headwater basin, then passes up through a saddle on the divide to the southwest and continues across Happy Gulch, a headwater of Willow Creek, a short tributary of Iditarod River west of Flat Creek. The southwestern end of the Flat Creek granite mass is a short distance southwest of Happy Gulch. Placer gold is found on Happy Gulch and Willow Creek.

The richest gold-placer deposits so far found in the Iditarod district occur on Flat Creek from 3 to 4 miles above its mouth. The bedrock origin of this gold is apparently the zone of alteration and mineralization along the contact of the granites with the sedimentary formations that cross the upper part of the valley. The placer mining claims that include the productive ground are of such irregular sizes and shapes that a general written description, unaccompanied by a detailed plat, can not give an intelligible idea of their location or extent with reference to one another, so individual properties will not be mentioned in this account. The side and headwater slopes of the valley are also covered by claims of various extent and area. About the head of the valley most of the claims are in the form of association groups that contain the equivalents of two to eight single 20-acre placer claims.

In general the prospected ground covers all of the valley floor of Flat Creek from mouth to source, but at present the most active mining development is on the upper part of Flat Creek, from 3 to 4 miles above its mouth. The gold-bearing deposits on this part of the creek are from 10 to 25 feet deep. They are composed largely

of gravels, sands, silts, and a considerable number of bowlders, mostly derived from the decomposition and erosion of the granite country rock that forms practically all the headwater slopes of the valley throughout the upper mile of its length. This granite is deeply decayed and its surface is thickly covered with large blocks and bowlders of the same rock, which are mostly residual accumulations of its more resistant portions. Some of these bowlders and slabs are fully 20 feet and a large number are more than 3 feet in their greater dimensions. To travel over these slopes often necessitates stepping from one bowlder to another, as there are many open spaces between them, although for the most part they lie as a closely packed mantle of débris from 5 to 20 feet thick with smaller fragments and cobbles wedged between them, and the slopes are partly covered by sandy soil and turf, on which grow some good spruce timber and dense thickets of alder and willow brush. A large part of the precipitation that falls about the head of the valley sinks beneath this mantle of loose rock and flows down by many underground channels between and under the bowlders, to reappear near the foot of the slopes and form Flat Creek.

Placer gold has been found in paying quantities along the lower slopes of the granite area, where the bedrock is decayed granite and the wash is of granite bowlders, cobbles, and gravels. This gold is, with little doubt, derived from the mineralized quartz veinlets that occur in the granite and where now found is concentrated from the residual granite sands by the numerous small streams that flow down the slopes. The gold is in rough, flaky pieces, some of them attached to angular fragments of quartz that appear as if they may be freshly separated from vein matter.

The richest concentrations of placer gold, however, are downstream from the granite contact, where they rest upon and within the hard, blocky fractured sedimentary bedrock as successive outwash accumulations derived from the numerous small streams of the granite headwater slopes. The sands, gravels, bowlders, and gold have been fed into the upper part of Flat Valley by these small streams and spread out below along its course by the larger combined flow of water. The unconsolidated deposits along the lower 4 miles of Flat Creek become progressively finer in texture downstream. Along the upper part of the valley bottom bowlders, coarse gravels, and sands occur in larger proportion than fine sediments, while in the lower parts of the valley the finer sands, silts, clay, and vegetable muck become greater in amount.

The distribution of the placer gold in the unconsolidated deposits along Flat Creek has apparently occurred in the same order as the deposition of the coarser and finer sediments. The gold appears to be

most abundantly concentrated along the upper part of the valley and to become less in quantity and finer in size downstream from its source, the richest placers being located from 3 to 4 miles above the mouth of the creek. This is apparently due to the probable bedrock origin of the gold at or near the contact of the intrusive mass with the sedimentary rocks that cross the head of the valley and also to the fact that the headwater streams flowing over the mineralized granites have gathered and dumped gold-bearing wash into the upper part of the main valley, where the combined drainage loses much of its grade and transporting capacity a short distance below the mineralized contact belt. In consequence of this the ability of the running water to concentrate the gold in the gravels and sands is greater on the upper section of the stream than elsewhere.

On the upper part of Flat Creek the coarse unconsolidated deposits are not overlain by a very thick barren cover of frozen sediment. The transporting power of the creek appears to be sufficient to carry most of the fine sediment farther downstream, for such deposits of silt with vegetable muck become thicker and more widespread toward the mouth of the valley.

The best pay layers in the washed deposits are the lowermost beds of gravels and sands from 1 to 3 feet thick that rest upon the bedrock surface and underlie from 16 to 20 feet of less productive or locally barren material. However, at some places on the upper part of the creek nearly the whole thickness of washed material contains more or less gold, fine light particles of it being found in the soil just beneath the turf. Much of the placer gold is also found from 3 to 6 feet down in the fracture cracks of the hardened sedimentary bedrock, where flaky pieces are embedded in thin seams of fine sediment that have been deposited therein. Without doubt this gold has been sifted down from the overlying sands and gravels by circulating water that has filtered through them into the crevices in the bedrock, the water washing the finer sediment and particles of gold from the sands into the bedrock crevices, where the sediment clogged the spaces and held the gold and the water passed away beneath.

WILLOW CREEK.

Willow Creek is a stream of about the same length and size as Flat Creek and has its source immediately southwest of the head of Flat Creek over a divide about 1,000 feet high. It flows into Iditarod River about 7 miles above Otter Creek. The principal headwater tributary of Willow Creek is named Happy Gulch.

Happy Gulch has its source on the west side of the same broad, gentle slope of the mountain mass on which rise the southern headwaters of Flat Creek, and like them it drains part of the same granite area. The southwest end of this granite mass is only a short distance *southwest* of the head of Happy Gulch. Along its northwest

the granite is in contact with the same sedimentary formations that occur on lower Flat Creek and these sedimentary rocks likewise form the country rock throughout the lower valley of Willow Creek. The contact between the granite and sedimentary rocks crosses Happy Gulch near its head. In fact, the gulch topography of this tributary begins near this contact and extends downstream as if it may be due to the fact that the sedimentary rocks in which it is cut are more easily cut down by stream erosion than granite. Although the sedimentary formations are softer than the granite, they nevertheless have been hardened to a considerable degree along their contact with the granite. This alteration is the same as that on Flat Creek. The metamorphism gradually diminishes away from the contact and at a distance of a mile the sandstones and shales are of ordinary hardness and texture.

Mineralization appears to have occurred at and near the contact. The granites are deeply decayed, and accumulations of partly residual and partly waterworn granite sands, gravels, cobbles, and bowlders, similar to those on the slopes of upper Flat Creek valley, occur throughout the upper mile of Happy Gulch. Placer gold of the same rough, angular, little-worn appearance as that found on upper Flat Creek, many pieces showing faces of crystalline form, occurs in the granite wash deposits along Happy Gulch where it cuts across the contact belt. The best concentration of gold appears to be in more or less disconnected layers of gravels and sands from 6 inches to 2 feet thick, mixed with bowlders that lie near the bottom of the unconsolidated deposits. These deposits vary from 5 to 10 feet in thickness. Their surface is covered by a growth of moss and turf and dense thickets of willow and alder brush.

A small amount of open-cut, ground-sluice, pick and shovel mining was performed on Happy Gulch during August and September, 1910, on what is named the Summit claim, which is near the head of the gulch and a short distance above the contact of the granite with the sedimentary rocks. This claim is about as far up the gulch as water in sufficient quantity for groundsluicing may be obtained. Even here the adequacy of the supply is largely dependent upon the occurrence of frequent rains on the mountain slopes above. Fortunately these slopes are extensive and of gentle grade, so the run-off is somewhat regular, and by digging small reservoirs enough water may be retained for small mining operations. The granite bedrock on the Summit claim is so deeply decayed that the action of running water quickly erodes down into it, and a ground sluice, if it is allowed to work in one channel too long, readily cuts below the gold-bearing waterworn material that rests on top of the decomposed bedrock.

Placer gold also occurs along the main valley of Willow Creek for several miles below Happy Gulch. The country rocks of this valley are shales and sandstones which are for the most part in a normal

unaltered condition; but within a zone which extends out about a mile from the granitic intrusive mass that crosses the upper part of Happy Gulch these sedimentary rocks have been altered and hardened by the deposition within them of considerable quartz in the form of numerous thin veinlets. This silicified condition of the sedimentary rocks appears to be more evident near the contact of the granitic intrusive mass and to become less marked away from it.

The present Willow Creek flows along the north or right-hand side of its valley, in a manner similar to Otter Creek, and cuts into a range of hills to form a line of low rock bluffs. Thus the greatest width of its valley floor, which is about half a mile, lies south of the stream, along its left side. The surface of the valley bottom rises gradually to the slopes of the bedrock ridge that bounds the valley on the south. This ridge separates Willow Creek from a southern tributary named Gold Creek, which joins Willow Creek about 1¼ miles below the mouth of Happy Gulch. This ridge between Willow and Gold creeks is composed of sedimentary rocks, and it lies within the zone that has been altered by the quartz mineralization which has apparently been induced by the intrusive granitic rocks that occupy the head of Happy Gulch.

The unconsolidated deposits of Willow Creek valley are largely frozen silts and clays, near the bottom of which are some thin beds of gravels composed mostly of partly worn fragments of the hard-shale country rock. Many of the pebbles in the gravel are angular, as if they had not traveled far enough to be well rounded, and may be derived from a neighboring bedrock source. In places they rest upon and grade by mixture into the broken-up and decomposed hard, shaly bedrock and locally they are mixed with sticky clay. Most of the frozen sediment is a dark-colored carbonaceous material that appears to be largely derived by disintegration from the shaly country rocks. These deposits vary in thickness from 10 to 25 feet. On top of them lies a cover of several feet of mucky vegetable humus and moss.

Some prospecting has been done by sinking and drifting on the claims that are located along the present course of Willow Creek near the low bluffs that border the north side of its valley, but the results obtained have not led to any noteworthy production of gold to date. Along the south side of the chain of claims that extend along Willow Creek from the mouth of Happy Gulch down to Gold Creek there is located an association group of placer ground about a mile long named the Haggerty Bench claim, which occupies practically all of the width of the sloping valley bottom that is not included within the creek claims already mentioned. On the lower end of the Haggerty Bench claim, a short distance above and between the forks formed by Willow and Gold creeks, an open cut about 12 feet deep has been

made by groundsluicing to test the value of the deposit. It is reported that this open cut yields about $1.25 to the square foot of surface. The bedrock in this open cut is a shattered hard shale or argillite, commonly called slate, which contains thin veinlets of quartz. The 12 feet of unconsolidated deposits exposed in the cut are frozen silts and clays. The clays are plastic and difficult to wash. The water for groundsluicing this open cut is obtained up Gold Creek by a ditch that brings it upon the upper margin of the sloping bench at an elevation sufficient to furnish enough pressure for hydraulicking the deposits with a canvas hose. It is planned to increase this water supply to about double the present quantity by digging a similar ditch from upper Willow Creek and joining the two ditches on the nose of the ridge that separates Willow and Gold creeks.

The placer gold on the lower end of the Haggerty bench is probably derived from either one of two sources, or possibly from both of them. One source may be the upper part of Happy Gulch, where the presence of gold in considerable quantity is evident, and the other source may be the ridge of altered sedimentary country rock that extends between Willow and Gold creeks from the granitic mass that crosses the upper part of Happy Gulch, although it is not known that the contact-mineralized sedimentary rocks on this ridge are gold bearing. However, if this is the case a concentration of placer gold from the ridge along the south side of Willow Creek valley would be a natural result to expect. In either case the gold that occurs along the south side of the valley appears to have been concentrated in its present position by Willow Creek at a time when it may have flowed nearer the south or left side of its valley. The present position of Willow Creek on the north or right side of its valley gives the impression that the channel of the stream has migrated across its valley bottom from left to right, and even now it is strongly inclined to work northward, as is shown by the low rock bluffs it is cutting along that side.

MINING METHODS.

The mining methods practiced in the Iditarod district may be briefly classified as prospecting and testing, stripping off overburden, excavating the stream-laid deposits and shattered bedrock which contain gold, conveying and hoisting the material to a washing plant, passing it through sluice boxes, removing the angular rock fragments that may clog sluices, and disposing of the tailings.

The prospecting or testing of the placer-gold deposits that have been mined in the Iditarod district is not difficult because they are comparatively shallow, their usual depths varying from 10 to 25 feet. Being shallow, they have been mostly mined by open excavations from the surface. A large part of the ground so far developed is in a

thawed condition, but frozen areas of large and small extent also occur. It is only in the frozen areas that underground or drift mining on bedrock may be done satisfactorily, for when thawed ground is opened the water it generally contains is liable to flood underground workings to such an extent that only expensive pumping will keep them free. Even in open pits seepage water often flows so abundantly that it has to be drained into a sump hole and pumped away. The original discoveries of gold in Otter Creek valley were made by sinking small shafts to bedrock, and most of the prospecting of properties preparatory to mining them has been done in this manner. During the winter of 1909–10 a moderate amount of sinking and drifting was done in Otter Valley to test the gold values in the ground, and at one or two localities this method has been continued in a small way during the summer, but in general this kind of work has been handicapped by encountering water in quantities large enough to flood the underground excavations. On the upper part of Flat Creek some prospecting has been done with a steam drill. Some ground was tested near the mouth of Flat Creek and on Willow Creek during the summer of 1910 by groundsluicing or washing out open cuts into the frozen deposits. These frozen deposits are mostly of silts and clays, the frost binder of which, when exposed to the action of air and running water, rapidly disintegrates them into flowing slimes that are removed in suspension by running water. This open-cut work, however, can be done only during the summer, or the season of running water, from May to October, and at localities where sufficient water is obtainable. If prospecting or mining is undertaken during the winter season it must be done by sinking to and drifting along bedrock, and if water seeps into these underground excavations in any considerable amount the work is generally abandoned at that particular place. Sometimes a short distance from a thawed place a solidly frozen spot may be found, where sinking and drifting may be carried on satisfactorily over a small area without interference by seepage water.

Owing to the shallowness of the gold-bearing deposits of the Iditarod and the largely thawed condition of the ground that contains the best values practically all the larger operations so far undertaken have been open excavations from the surface down to and into bedrock. This involves the mechanical removal and handling, in one way or another, of the whole thickness of the unconsolidated deposits and that part of the disintegrated and loosened bedrock which contains profitable amounts of placer gold.

It is generally necessary to remove a variable amount of more or less barren material, such as brush, moss, humus, soil, and silt, from the upper part of the unconsolidated deposits. This stripping off of the barren overburden is done by chopping and grubbing away the

vegetation and, if running water is available in sufficient quantity and the grade of the surface favorable, directing one or more streams over the ground by several channels until the surface material is washed away or groundsluiced. If this work can not be done with running water, horse or steam scrapers are used to move the barren material aside. The steam scrapers are similar to ordinary horse scrapers except that they are of larger capacity and are operated by a system of wire cables and steam hoisting engines so arranged that the scoop is filled by drawing it through the earth and then dragged aside to a dumping ground by a cable attached by a pulley to the top of a stout, securely guyed mast, the scoop being then automatically dumped by a tripping arrangement.

After the placer deposits are stripped of the barren overburden it is necessary to excavate and elevate the gold-bearing material into sluice boxes through which it is washed by water to separate the gold from the sands, gravels, and fragmentary bedrock. In the Iditarod placers the bottoms of the valleys are too flat to allow lines of sluice boxes to be set up on the bedrock grades and the gold-bearing material to be shoveled directly into them, as may be done in many placer districts. In order to get sufficient grade to the box lines for washing the gold-bearing material and room to dump the tailings from the lower ends of the sluices it is necessary to erect lines of boxes on trestles from 15 to 30 feet high and to elevate all the gold-bearing material to the upper end of the sluice boxes. The hoisting is done by means of a specially constructed sheet-iron dump bucket attached to a running cable that passes through a combination of pulleys mounted in a carriage which runs along a fixed cable that is stretched across the excavation from the top of a firmly guyed mast. This mast is placed so that the upper end of the fixed cable is suspended above a dump box at the head of a line of sluice or riffle boxes. The running cable is adjusted so that the bucket may be lowered or hoisted at different places in the excavation beneath the fixed cable and drawn along that cable to its upper end near the mast, where it automatically trips and dumps its load on an apron or steeply inclined platform. From this the material slides down into the upper end of the riffle boxes, to be washed through them by a stream of water conveyed to the sluice by a flume, which, like the sluice boxes, has to be elevated on a trestle in order to raise it to the required height.

Steam-boiler equipment varying from 20 to 60 horsepower has been used to operate the hoisting engines at the several plants. This amount of power is considered insufficient by some operators, who intend to install larger boilers in the future. Wood is the only fuel available, and as the supply is none too abundant or convenient it forms a considerable item of expense.

With the exception of the steam hoisting and scraping of the unconsolidated deposits as described above, practically all of the work of mining is accomplished by manual labor, from 10 to 60 men being employed in and about the different excavations according to the magnitude of the operations undertaken. Most of the men work in the open pits digging up the gold-bearing material with picks and shovels and conveying it to the hoist buckets in wheelbarrows. Several men are generally required at the sluice boxes to keep the water and gold-bearing material properly passing through them. Most of the larger angular pieces of bedrock are not allowed to go through the riffle boxes because they are liable to become wedged and clog them. To avoid obstructing the boxes with this angular rock material it is forked out near the head of the sluice after the gold-bearing sediment attached to it has been washed off either by the sluice water or by a stream of water from a hose. The rounded gravel, sand, and silt is washed through the boxes and allowed to stack up at their lower end as tailings. Generally the sluice boxes are erected high enough above the ground to afford space for the disposal of the tailings by gravity, by occasionally changing the arrangement of the boxes, but in some places the tailings must be moved aside mechanically by a scraper or hoist to prevent blocking the dump.

MINING COSTS.

The mining operations conducted in the Iditarod district during 1910, the first year of its development, can not be considered normal, because the district has suffered from the effects of many conflicting conditions such as often attend the opening of a new part of Alaska that is comparatively easy of access. The first year or so of the development of a new placer gold district in Alaska is generally a period of more or less confusion and uncertainty for both the mining operations and the dependent commercial activities. This is probably more pronounced in the Alaskan gold placers because there the natural conditions are more severe than in most other countries.

When placer gold is discovered at a new locality in Alaska, if a general opinion that the district offers considerable mining promise gains popular acceptance, the movement of population to the new locality during the first years of its development is often out of all proportion to its gold-productive possibilities. A condition of overpopulation has characterized the early history of many of the placer-gold districts of Alaska, especially those which are fairly accessible by summer routes of water transportation, and this condition often continues until a district has passed its period of maximum development. On the other hand, districts which are sufficiently removed from steamboat transit to be difficult to reach are seldom overpopulated, and the

mining development of such districts to their full possibilities generally lags for want of sufficient supplies and equipment. This prevents the exploitation of deposits which in more accessible localities could be mined with a profit that would sustain a considerable population.

As a rule the mining and commercial activities of an Alaskan placer-gold district, although closely interrelated and intimately dependent upon each other, are rarely in economic harmony. This lack of adjustment often continues throughout the history of a district and is directly reflected in the cost of mining. In most places, especially in the interior of Alaska, transportation is a primary factor governing mining development and is of most vital importance, a high cost of mining generally being chargeable to the lack of cheap and satisfactory facilities for the conveyance of ample supplies from the United States to the placer-gold districts. The mining industry is largely controlled by this factor, for no matter in what part of the Territory mining is undertaken the problem of transportation enters as a primary influence in determining the relation of the mining costs to production, and the difficulty or ease with which a particular locality may be supplied with the food, clothing, implements, and machinery required by a mining population determines the possibilities of exploiting deposits of different values. Practically all these supplies are obtained ready-made from the United States, and the freight charges for their carriage to points on the water routes of transportation, especially in the Yukon Valley, are considerable. The cost of transportation, however, is generally much increased before the supplies reach their final destination, for in most cases it is necessary to move them from 5 to 50 miles overland and the cost of this, especially for large or heavy pieces, such as boilers and hoists, increases enormously with the distance.

Probably it will never be possible to obtain the data necessary to present a complete analysis of the commercial mining condition of a placer-gold district in Alaska, especially for the first years of its development, because reliable evidence in the form of accurate figures is rarely obtainable. Some of the more systematic operators keep business accounts, but a great amount of placer-mining work is done without keeping records of the costs. The few statements of costs available show that the cheapest mining in the Iditarod during 1910 cost 22 per cent of the production of a particular operation. Another comparatively low-cost operation was performed for 32 per cent of the production. These costs are the lowest reported. On the other hand, much of the mining so far done has cost 70 per cent or more of the production. The general average cost of mining in the district for the season of 1910 probably was between 50 and 60 per cent of the total production. The cheapest operations are much below the

average of the district and are probably nearly as low as will ever be accomplished by the methods used. Although costs may be reduced if conditions become better balanced, such results probably will be attained only upon small tracts of favorably situated ground. The deposits mined at the lowest costs cited above are about 10 feet deep and rest upon a soft bedrock of deeply decomposed granitic rock that may be readily scraped up and very easily washed after an overburden of muck and silt is removed by groundsluicing. The actual cost of mining this deposit was about 28 cents per cubic yard. This is as low as the cost of some dredge mining on Seward Peninsula, where the lowest cost of placer-gold dredging so far attained is 18 cents per cubic yard. In the Iditarod district it will cost considerably more to install and operate dredges than on Seward Peninsula, as transportation and fuel will be far more expensive, so it is doubtful if dredge mining can be conducted in the Iditarod for 18 cents per cubic yard.

The possibility of placer-dredge mining on considerable tracts of the flat-lying stream deposits that cover the valley floors of Otter and Flat creeks, which are presumed to be gold bearing to a greater or lesser degree and extent, has been discussed in a preliminary manner by some of the persons interested in ground on these creeks. Such an enterprise should not be undertaken without first securing a satisfactory community of interests for considerable tracts of placer ground and prospecting them thoroughly enough to determine the extent and thickness of the gold-bearing beds, so as to enable reliable estimates to be made of the amount of gold that occurs, with known quantities of the material to be handled by a dredge, including the barren overlying deposits with which the gold-bearing material is associated. Due allowance must also be made for the difficulties that may be encountered by dredge buckets in digging up the shattered bedrock, in the cracks of which much of the gold lies, and also in handling the bowlders which are present in the Iditarod deposits in considerable numbers. Experienced dredger men should be consulted before such an investment is made.

PRODUCTION.

Commendable energy has been shown by the real mining element of the Iditarod district in overcoming the obstacles the mining situation presented to them; for the camp, so far, never has promised to produce enough new wealth to satisfy even the reasonable expectations of all the people who have interested themselves in the district in various ways. Before June, 1910, very little was definitely known about the occurrence of the placer gold and there was not an adequate supply of mining equipment at hand with which to work, but after the season opened no time was lost in commencing operations which

would demonstrate the mining possibilities of the district. The necessary boilers, hoists, etc., with which to perform effective work were brought to the head of steamboat navigation on Iditarod River and thence moved with considerable difficulty and expense to the better-known placer tracts on Otter and Flat creeks, where they were quickly installed and actively operated without delay until the freeze in October.

When it is considered that the district has been greatly overpopulated by a class of persons whose intentions are not to mine but to gain indirectly from the results of the miners' labor, the first season's gold production has been as large as could be expected. Of the 2,500 persons who entered the Iditarod district during 1910 not more than 1,000 engaged in work directly related to its mining development. The remainder, or much over half of the population, had no other intentions than to engage in parasitic pursuits of minor importance to mining, and it is probably unfortunate that the district has been thus overburdened, especially by so many persons who have shown overenthusiasm in town-site booming and kindred speculative enterprises.

The gold output of the Iditarod for 1910 amounts to about $500,000 in value, of which about $200,000 may be credited to Otter Creek and the remainder, $300,000, to Flat Creek. There was also a few thousand dollars' worth of gold mined from Black and Willow creeks in the course of preliminary development work.

OUTLYING PLACER-GOLD LOCALITIES.

The one significant result of the overpopulation of the Iditarod has been to stimulate a widespread search for placer gold throughout the surrounding territory, particularly south of the present center of mining on the headwater branches of large streams that flow into Kuskokwim River from the divide that separates them from the Iditarod drainage. The results of this movement, which during August and September, 1910, was participated in by over 500 men and reached the magnitude of a "stampede," indicate that prospects of placer gold occur in several areas of moderate extent within the valleys of Moore, Jualin, Donlin, and Crooked creeks, which are south of and opposite the headwaters of Otter and Bonanza creeks. Prospects are also reported to occur on Little Creek, a tributary of Iditarod River about 75 miles above Otter Creek. Although there appears to be little doubt that some prospects of placer gold have been discovered at particular spots of small extent on several of the smaller tributaries of the streams named above, it is not possible at this time to make any definite statements about the extent or richness of these new gold-bearing areas. The men who participated in this stampede movement did not apply their energies toward making or verifying discoveries of placer gold, but, after the

manner now commonly practiced all over Alaska in such cases, they devoted practically all their time to traveling rapidly over the country and hastily placing location stakes and notices so as to embrace vast tracts of land for placer mining without making any effort to determine its gold-bearing character (a primary requisite of the law), simply assuming that placer gold may possibly occur in some of the ground located from the meager fact that there may be an actual occurrence known within several miles, perhaps in the same valley or some adjacent basin. Oftentimes, however, not even this small stimulus is considered essential, the optimistic imagination characteristic of the gold seeker being enough to make him think that, to use the common expression, "the country looks good." Indeed, the custom of making wholesale locations of land in the form of countless association-group claims of 160 acres each, for the ostensible purpose of placer mining, has become so general throughout Alaska during the last four or five years that it is now unusual in many districts to find ground located as single 20-acre claims. It is not uncommon for several men in partnership or even one individual, sometimes provided with powers of attorney of a number of absent persons, to claim by priority of location from 25 to 50 and occasionally as many as 100 association-group claims of 160 acres each—in other words, to make ridiculous claims of intentional mining rights on 50,000 to 150,000 acres of the public domain. The manner in which this practice appears to be countenanced by Alaskans gives ground thus falsely claimed a sort of concessionary value that is considered as an asset, by which claimants hope to profit if by chance a genuine discovery of gold is eventually made upon or near some of their illegal holdings. It is a matter of common knowledge throughout Alaska that no actual discoveries of gold are made on 90 per cent of the claims staked when they are first located for placer mining. The apparent purpose governing the whole matter is to first get what is considered a prior control of large tracts of land with the idea that gold may be discovered upon some of it afterward, which discovery may then be turned to the financial advantage of the persons who claim priority of location but who have done nothing to deserve reward. In brief, the primary object of the mining laws, whose intent is to encourage citizens to search without restriction for mineral wealth upon the public domain and, if they actually discover it, to protect their rights as individuals therein as long as they give evidence of reasonable interest in the exploitation of such mineral wealth, is utterly ignored. The exploitation of Alaska's placer deposits at the present time is apparently suffering from the chaotic condition brought about by an utter contempt for both the mining laws and the common rights of the public in the matter.

Popular opinion throughout Alaska seems to strongly denounce the abuse of the locating privilege by the unrestricted use of powers

of attorney and association-group staking. The personal opinions expressed by most individuals are to the effect that such methods should be abolished, yet they do not intend to deny themselves such privileges as long as they have no guaranty that others will not take advantage of them.

CONCLUSION.

At present it is not possible to make conclusive statements regarding the future mining possibilities of the Iditarod district. During the summer of 1910 enough experience was acquired with the placer deposits on Otter, Flat, and Willow creeks to define fairly well the character of the unconsolidated stream deposits where mined and the conditions surrounding the occurrence of the placer gold in them. The work performed shows that there is a general similarity in the kinds of unconsolidated deposits on these three streams, but there are some variations in the relative proportions of the finer and coarser materials, in their thickness, and in the presence or absence of perpetual frost. All the deposits belong to the class of shallow placers, which may be best mined by open surface excavations.

Though considerable prospecting has been done to determine the extent of the placer-gold deposits and though their limits of distribution on Otter, Flat, and Willow creeks seem to be well defined in some directions, it can not be stated now with any degree of certainty how extensive they may be or how much gold they may contain. It may be said, however, that the mining situation on these three creeks is well in hand and without doubt will soon adjust itself to the conditions surrounding the occurrence of the placer gold. No doubt more ground may be mined with a profit in the future than would have been possible under such conditions as were prevalent during 1910.

From what is known of the occurrence of placer gold in the Iditarod and the adjacent districts of Innoko and Tuluksak it appears probable that there may be other similar but separate areas of auriferous mineralization of moderate extent distributed in a more or less scattered manner throughout the central part of the Kuskokwim Mountains. In this province the indications seem favorable for the discovery of gold-bearing stream placer deposits at or near mineralized zones of contact of granitic intrusive rocks with the sedimentary formations. These areas, however, do not appear to form a continuous gold-bearing belt.

The probable future expansion of placer mining in this region will depend chiefly upon the discovery of more occurrences of local gold-bearing mineralization in the vicinity of intrusive masses or dikes of granitic rocks such as are known to occur at several places along the Kuskokwim Mountains from the headwaters of the Innoko and Tuentna on the northeast to the Tuluksak on the southwest. At this date several new gold-bearing localities of this kind are reported.

Those nearest the Iditarod on Jualin, Donlin, Crooked, and Little creeks have attracted the most attention, but portions of the valleys of Moore Creek, a headwater branch of the southwest fork of the Takotna, and of the large northeast branch of this river, which is called the Tuentna or Nixons Fork, have also aroused enough interest to be extensively located upon in the customary wholesale manner for placer mining. The results of prospecting that will be carried on at all these new localities during the present year will be very important in determining the extent and activity of placer mining throughout the Kuskokwim Mountain region.

Northward from the Innoko district the Kaiyuh Mountains may prove a good field for prospecting, because granitic intrusive rocks similar in lithology to those that appear to have brought about the auriferous mineralization of the Innoko and Iditarod districts are known to occur there at many localities.

THE SHUNGNAK REGION, KOBUK VALLEY.

By PHILIP S. SMITH and HENRY M. EAKIN.

INTRODUCTION.

In the central part of the Kobuk River basin there is a mineralized area in which placer gold has been mined and copper, gold, lead-silver, and asbestos deposits prospected. These deposits had not been studied by members of the Survey before 1910. The region was the scene of a stampede of gold seekers in 1898, but although a few thousand dollars in gold was produced annually for several years, in 1910 the district was nearly deserted. Many problems of importance both to the prospector and to the geologist still remain to be solved by more careful examination, but until such studies are made it has seemed expedient to set forth the general geologic observations and to point out some of the important subjects that require further investigation.

The region considered in this report lies north of the Arctic Circle, adjacent to the 157th meridian. Particular attention is given to the region between Kogoluktuk River on the east, Shungnak River on the north and west, and the Kobuk on the south. Although this small area is the place where minerals of economic importance have been found and is directly the subject of this report, a somewhat larger region is described in order to show the setting or general relation of this field to the geology and geography of the central part of the Kobuk Valley. A still broader and more comprehensive account of the features of northwestern Alaska is in preparation and will serve to extend the area covered by this more detailed report.[1]

GEOGRAPHY AND TOPOGRAPHY.

Figure 19 shows the general location of the area, which for convenience will be called the Shungnak region. The settlement from which this name is taken is about 250 miles from the mouth of the Kobuk, measured along the crooked course of the river. Measured

[1] Smith, P. S., Geology and mineral resources of northwestern Alaska; in preparation.

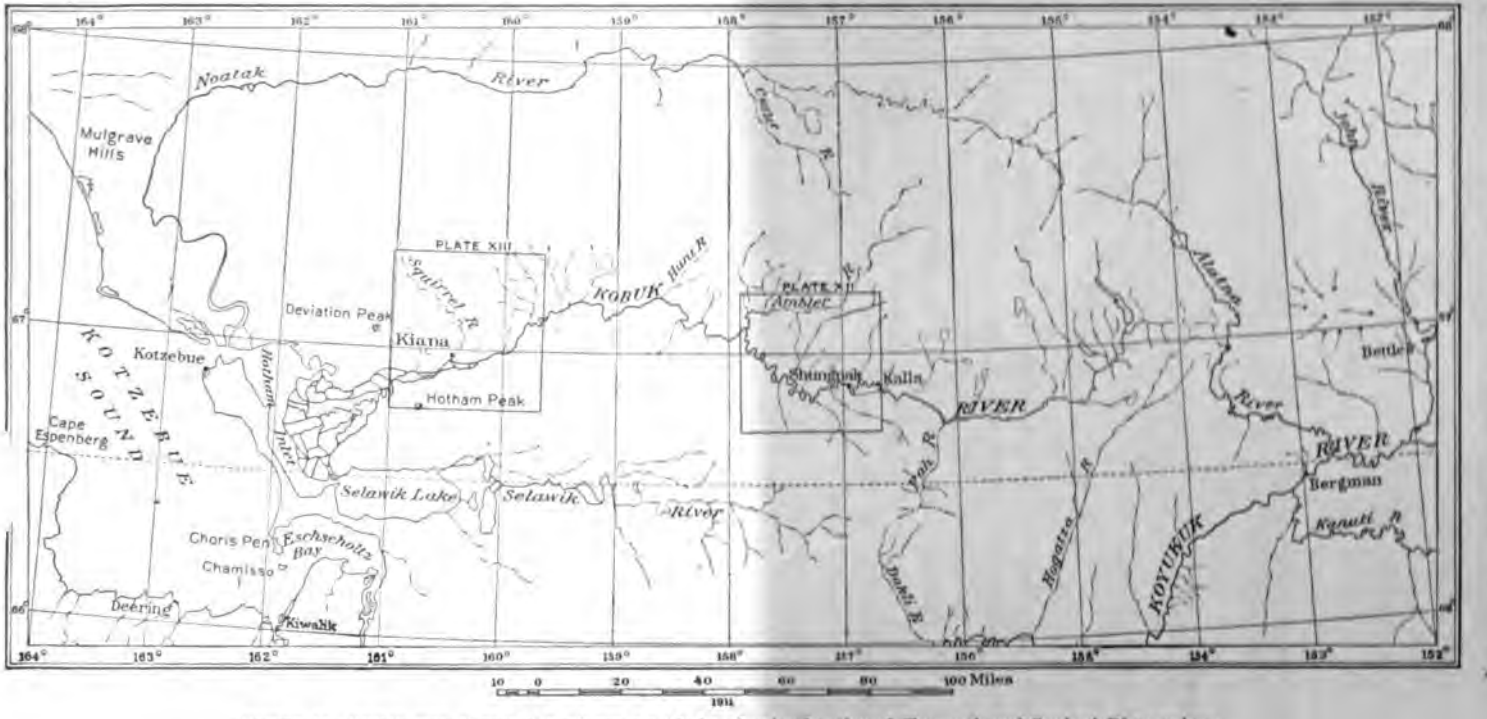


FIGURE 19.—Sketch map of part of northwestern Alaska, showing location of Shungnak and Squirrel River regions.

in a straight line, however, it is only a little more than half that distance. Throughout this distance the stream is navigable for boats drawing as much as 3 feet, and an even greater draft could be carried if it were not for shallow bars at the mouth of the river and the crooked, shifting course of the channel farther upstream. The best approach to this region is by way of Kotzebue Sound and Kobuk River, for a mail boat from Nome touches at Kotzebue three times a month, and launches and barges can be taken there for points up the river. A description of the method of reaching Kiana, at the mouth of Squirrel River, is given on pages 306–309 and applies to reaching Shungnak as well, but the river trip continues for another 175 miles and consequently takes from 5 to 10 days longer. In 1901 Mendenhall reached this region by way of Koyukuk and Alatna rivers, and this route has been traveled by natives and prospectors for many years. This is, however, a roundabout way of reaching Shungnak and is not suitable for bringing in supplies, etc. In 1910 the writers reached the region by going overland from the Koyukuk near the mouth of the Hogatza, but this is not a direct route and is not a feasible way of reaching the Kobuk except during the winter months.

RELIEF.

The larger-scale map (Pl. XII) shows more details of the Shungnak region than are given on the sketch map (fig. 19). Although the topography of the map shown on Plate XII is in a measure obscured by the patterns used to denote the several geologic formations and groups, the major features of the relief are evident. From this map it will be seen that there are five more or less distinct belts of relief. The most southern of these belts is a range of hills, averaging about 2,000 feet in elevation, succeeded toward the north by the Kobuk Valley Flats. These are in turn succeeded by a narrow range of hills reaching heights of about 3,000 feet in the eastern part and gradually decreasing in altitude toward the west. North of these hills is a lowland 3 to 4 miles wide which is succeeded toward the north by rugged mountains.

The southern hills, called by Mendenhall in 1900 the Sheklukshuk Range, form only a narrow highland between the Kobuk lowland and the Selawik lowland on the south. These hills have been only slightly explored, but they are probably not more than 10 to 15 miles wide and trend in a general east-west direction. The higher points reach elevations of 4,000 feet, but the average elevation is only about half as great.

The Kobuk lowland, so called from the large river which traverses it, is from 10 to 15 miles wide and has an average elevation of 200 to 400 feet above the sea. The highlands which bound this lowland to

the north and south rise rather abruptly from the nearly featureless plain and emphasize by their sharpness the plain's slight relief. The flood plain of the Kobuk occupies a width of several miles along the central part of the lowlands, distinguished by the occurrence of numerous bayous and crescentic lakes marking former courses of the river. The higher parts of the lowlands on either side slope from the bordering hills toward the river, descending to the slightly lower level of the flood plain with more or less distinct bluffs. The surface of such parts of the lowlands is not altogether smooth, as locally there are lakes of irregular shape and small size.

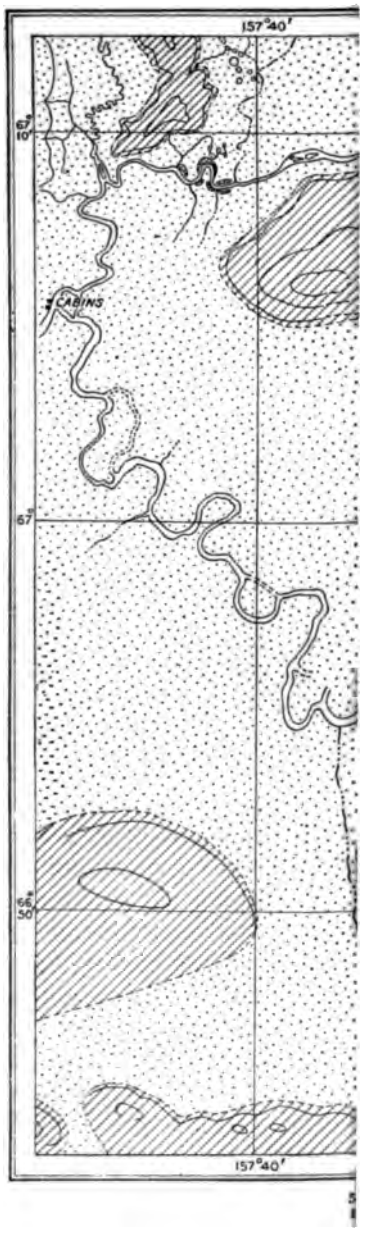
North of the Kobuk lowland, as already noted, a range of hills, in places 3,000 feet or more in height, rises abruptly and forms a strip of highland 10 to 12 miles wide toward the east but gradually narrowing toward the west as it approaches the junction of the Kobuk and the Ambler. No name has been given to these hills, though they appear to be the continuation of Lieut. Stoney's Schwatka Mountains.[1] Owing, however, to the misconception that existed as to the general topography and to the fact that the name as applied does not separate this front range from the main range to the north, it has been proposed to call the feature above described the Cosmos Hills. This name is given because Stoney's winter camp on the Kobuk was called Fort Cosmos and the stream near his camp, which heads in these hills, was also called by this name. These hills are characterized by a general east-west trend but are considerably dissected, so that the higher points are irregularly distributed.

Beyond the Cosmos Hills is a lowland not so extensive as the Kobuk lowland but still a marked topographic feature. To the west this lowland is drained by Ambler River, but to the east it is traversed by Shungnak and Kogoluktuk rivers and it persists even farther east, if scattered observations and reports are to be trusted. Even where it does not contain a large stream this lowland is still preserved and it is believed to be a significant structural feature. A particularly clear illustration of a portion of the lowland without existing streams is shown by the area between Ambler and Shungnak rivers. At this place the distance between the two streams is about 3 miles and the elevation of the divide between the two is not over 200 feet. In order to have a short descriptive term for this feature it will be called the northern lowland.

North of the northern lowland the mountains rise steeply to heights of 3,000 to 4,000 feet above the main streams, so that their relative relief is strong. Only the southern margin of these mountains is included within the mapped area. From a study of Stoney's map it is evident that this highland belongs to the group of hills named by him the Baird Mountains, and by this name they will be

[1] Stoney, G. M., Naval explorations in Alaska. Annapolis, 1900, map.

U. S. GEOLOGICAL SURVEY



Sand, gravel, and silt, fluviatile, lacustrine, and glacial origin

Mesozoic-?
Sandstones
and

GE

called in this report. Serrate crest lines and deeply intrenched valleys characterize these mountains and give a rugged, inhospitable appearance to the landscape.

DRAINAGE.

The drainage of the Shungnak region presents a number of different types of streams, many of which have a complex history. The master stream is the Kobuk, which heads in the hills far to the east and flows westward, receiving tributaries that head in the highland areas along its course. The Kobuk is a large river, having a width near Shungnak of 600 to 800 feet and a current of 2 to 4 miles an hour; the depth varies, being in many places as much as 15 to 20 feet. It has a meandering course through the lowland and many of its deserted channels form sloughs and oxbow lakes. The strength of the current is sufficient, however, to make it an easy river to descend, and above the delta even one unfamiliar with the river finds little difficulty in avoiding blind channels. Within the mapped areas there are no rapids or treacherous stretches.

Kogoluktuk, Shungnak, and Ambler rivers are the largest tributaries to the Kobuk from the north. All these streams head in the Baird Mountains and flow in glacially sculptured valleys, receiving many tributaries until the southern face of the mountains is reached. Thence they traverse the northern lowland and then flow in rocky canyons through the highlands of the Cosmos Hills, later traversing the Kobuk lowland to join the main stream. This course, transverse to the dominant geologic structure and also to the topographic structure, indicates the complex history that made such drainage possible. Some suggestions as to the origin of this peculiar drainage are given on page 287, where the course is explained as in large measure due to glaciation and structure.

All these streams carry large volumes of water during the early spring and summer and with the exception of the easternmost are not fordable during ordinary seasons. Owing to their heading in the high mountains they derive a large amount of water from melting snow and so maintain a more constant flow than the streams not having a similar supply. In the highlands their courses are comparatively straight, but in the Kobuk lowland some of them meander in irregular curves. Low falls and rapids occur on these streams as they traverse the Cosmos Hills; in fact, the name Kogoluktuk is said to mean in the native language "river with falls."

The larger streams entering the Kobuk from the south have not been explored, and little is known of their geography except from the reports of natives. Kuikcherk, Pick, and Black rivers are the three largest streams, and probably all of them head in the Sheklukshuk

Range. They are smaller than the northern tributaries because they drain smaller basins and also because the lower hills in which they head are not so effective in snow storage as the higher Baird Mountains to the north. In their lower courses these streams are rather sluggish and their water is in large measure derived from the tundra through which they flow. The dark swamp water is suggested by the name Black River, given by Stoney in 1886 to the westernmost of these streams.

In addition to the larger tributaries there are many smaller streams originating in the highlands and entering the main stream independently or joining one of the larger branches. The streams from the Cosmos Hills show many intricacies, as they join the transverse-flowing streams, such as Kogoluktuk and Shungnak rivers. Thus many streams heading on the north side of these hills flow northward to the northern lowland or a transverse stream, where they turn abruptly and cross the range and thus enter the Kobuk. One of the best examples of this feature is Ruby Creek, which heads within 3 to 4 miles of the Kobuk lowland but flows northward for 7 to 8 miles before joining the Shungnak; thence its waters are carried southwest for about 20 miles before reaching the Kobuk. This condition prevails in spite of the fact that near its head there is to the south a pass not over 400 feet above the Kobuk, which has evidently been occupied by former drainage.

Passes similar to the one described at the head of Ruby Creek, although at somewhat higher elevation, are found at the head of many of the other streams. For instance, Cosmos Creek heads practically on the southern slopes of the northern lowland but flows southward across the range to join the Kobuk. These examples serve to show that many of the valleys through the Cosmos Hills have been eroded by agencies other than the existing streams and that the present rivers have had their courses in large measure determined by this earlier topography. It is believed that these passes and transverse valleys are best explained not as due to antecedent streams which persisted or failed to cross the Cosmos Hills during the possible deformation of the region but as due to drainage modifications induced by glaciation in the Baird Mountains and contiguous territory in comparatively recent time.

CLIMATE.

There are but few data as to the meteorologic conditions prevailing in the Shungnak region, though there are more observations here than in other parts of the Kobuk Valley. Mendenhall summarized the available temperature observations as follows:[1]

[1] Mendenhall, W. C., Reconnaissance from Fort Hamlin to Kotzebue Sound, Alaska: Prof. Paper U. S. Geol. Survey No. 10, 1902, pp. 54-55.

Summary of temperature observations on Kobuk River, 1885–1899.

Date	Minimum.	Maximum.	Mean.	Authority.
1885.				
July	32	70	49	Lieut. Stoney.
August	32	68	47	Do.
August	35.5	68	48	W. L. Poto, U. S. Geol. Survey.
September	5	69	39	Lieut. Stoney.
October	− 4	46	16	Do.
November	−44	15	− 9.5	Do.
December	−65	29	−12.4	Do.
1886.				
January	−70	31	−12.4	Do.
February	−65	26	−22.5	Do.
March	−38	36	− 3.8	Do.
April	−22	49	13	Do.
May	14	65	35	Do.
June	32	74	49	Do.
1898.				
July			57.6	McElwaine.
August			50.15	Do.
1899.				
February	−67	10	34.27	

As the mean annual temperature of the region is far below the freezing point, the presence of ice exerts an important control on the length of time that placer deposits can be worked. Snow may be expected in the highlands during almost any month of the year. According to Cantwell [1] the hills west of the Ambler were snow covered on August 9, 1885, and in 1910 the hills above 2,000 feet in elevation east of the Kogoluktuk were covered with snow on July 20. In 1885, according to Stoney, [2] ice had formed on most of the small streams by September 23 and along the main streams by the 25th. By October 18 the main river was frozen so that it could be crossed. Freezing continued until in February the ice had a maximum thickness of 5½ feet. On May 19, 1886, the ice along the banks of the Kobuk began to crack, and by June 6 of that year the river was free of ice. Joseph Grinnell,[3] who spent the fall of 1898 and the spring of 1899 a little west of the Shungnak region, reported that on October 15 the Kobuk was full of ice and by the 21st the ice was a foot thick. In the following spring the ice began to break on May 24, and by the 31st the river was free. It should be noted, however, that while the river itself breaks by June 1, Kotzebue Sound remains frozen until the first week or so of July, and therefore communication with the outside world is seldom established before the later part of July or even the first of August.

No instrumental determination of the precipitation is available and but few observations even as to the number of rainy days have been made. W. L. Poto,[4] a member of the Mendenhall party, is

[1] Cantwell, J. C., Exploration of the Kowak River, Alaska: Report of the cruise of the Revenue Marine steamer *Corwin* in the Arctic Ocean in the year 1885, Washington, 1887, p. 47.

[2] Stoney, G. M., Naval explorations in Alaska, Annapolis, 1900.

[3] Grinnell, Joseph, Gold hunting in Alaska, Chicago, D. C. Cook Publishing Co., 1901, pp. 79–84.

[4] Mendenhall, W. C., op. cit., p. 55.

quoted as recording 15 rainy days during August, 1885, and McElwaine[1] reported for June, July, August, and September, 1898, 16, 11, 18, and 12 rainy days, respectively. During 1910 the authors were in the Shungnak region from July 22 to August 11, inclusive, and the number of rainy days and duration of precipitation were as follows:

Precipitation in the Shungnak region, July 22 to August 11, 1910.

July 22	Showers and rain.
July 24	Rain in evening.
July 25	Rain all day.
July 26	Rain all day.
July 28	Mist and rain; heavy rain in evening.
July 29	Rain.
July 30	Heavy mist in morning.
Aug. 2	Rain.
Aug. 3	Rain in morning; showers in afternoon.
Aug. 4	Heavy mist and rain.
Aug. 5	Rain and heavy mist.
Aug. 6	Rain.
Aug. 7	Rain.
Aug. 8	Threatening in morning; cleared later.
Aug. 9	Rain all night; foggy in morning; showers in afternoon.

From this it will be seen that of the 21 days spent in the Shungnak region 15 were marked by showers or rain. It should, however, be noted that last year was exceptionally wet, and therefore the figures by no means represent average conditions. There is, on the other hand, little room to doubt that most of the precipitation comes during the summer, so that July and August are usually the wettest months

VEGETATION AND ANIMALS.

Owing to its high northern latitude the Shungnak region has a typically subarctic flora. Timber is found mainly along the larger streams and does not extend on the mountain sides to any considerable elevation. Spruce and birch are practically the only trees that grow to sufficient size for lumber, and only spruce is large enough for cabin logs or sluice boxes. Stoney[2] notes that the largest spruce tree seen by him in the whole Kobuk Valley was near Cosmos Creek. It measured 80 inches in circumference at the base and 68 inches at a height of 6 feet above the ground and was 80 feet tall. This was an unusually large tree, however, and the average spruce does not exceed a foot in diameter. In the higher parts of the region even spruce is wanting, and the prospector is compelled to resort to scrubby willows and alders for fuel.

Berries are exceedingly abundant on the unforested slopes of the highlands and on many parts of the lowlands. Blueberries are

[1] Mendenhall, W. C., op. cit., p. 54.

[2] Stoney, G. M., op. cit., p. 83.

particularly plentiful on the higher parts of the Kobuk lowland where trees and bushes are absent. Salmon berries are found on all parts of the lowlands and are so plentiful that people and animals depend on them for food. Some currants and cranberries were seen, but they are not as abundant as the two other kinds of berries.

Grasses for stock are found on the lower hill slopes and on the surface of the lowlands. Mendenhall [1] notes rye grass, blue grass or redtop, and a variety of bunch grass as the more usual species. Horses show a strong liking for the so-called goose grass, an equisetum, but it seems to contain little nourishment. The grasses flourish particularly in the neighborhood of the old settlements and camps and quickly spring up in the burned-over areas. None of the grasses seem to stand frost well and all appear to wither and lose their strength-giving qualities as soon as freezing nights begin. This is probably due to their exceedingly quick rank growth.

There are but few game animals now in the Shungnak region except bear. These are found mostly back in the hills or along the unfrequented streams. Both black and brown bears are reported. Caribou have been shot at several places within the region, but they are not numerous and the natives have to travel far to obtain their supply. There is, however, a herd of reindeer in the Sheklukshuk Hills and strays from this herd have probably been taken for wild caribou. Small fur-bearing animals, such as fox, mink, and marten, are occasionally caught, but they are found in no great numbers and are becoming scarcer each year.

Fish are abundant in almost all the streams. Salmon is one of the most important food supplies. These fish are particularly abundant in the Kobuk and during the last week of July and the early part of August native fishing camps are established at several places, especially just above the mouths of Kollyoksok and Black rivers. A large white fish, known to the natives as "she," is also caught in the Kobuk and is much prized for food. Grayling can be found in almost all the side streams and mountain brooks. Trout, probably salmon trout, weighing as much as 3 or 4 pounds each were caught in Dahl Creek and are reported from many of the other streams.

Many birds are found in the Shungnak region. Most important for food are ptarmigan, spruce hens, and ducks. Owing to the cold climate these can be kept for months during the winter without spoiling. Beside these game birds many song and other birds are either summer visitors or live permanently in the region. Grinnell [2] gives a list of the birds wintering in the region near the mouth of the Ambler, noted by him, as follows: Pine grosbeak, redpoll, spruce grouse, ptarmigan, three-toed woodpecker, jay, and chickadee. The

[1] Mendenhall, W. C., op. cit., p. 57.
[2] Grinnell, Joseph, Gold hunting in Alaska, pp. 58–60.

same writer states that the first bird from the south arrived in 1899 on April 22. After that date many familiar birds, such as sparrows, thrushes, sandpipers, robins, loons, and blackbirds, came to the region for the summer.

SETTLEMENTS AND POPULATION.

In 1910 there were only about a dozen white people in the entire Shungnak region, though in 1898, when a rush to the Kobuk was in progress, there were several hundred. The only village at the present time is Shungnak, where the United States commissioner and recorder for the district formerly lived and where a post office is maintained during the six winter months. A Friends mission has also located there. The town is the headquarters of the Government schoolteacher and superintendent of the reindeer herd. There is a small store kept by a trader, but usually not many supplies are kept in stock, so that by the end of the winter they are practically exhausted. Around this white settlement a group of native camps has grown up and before the fishing season commences over a hundred natives are settled within a short distance of the white men's cabins.

Three or four prospectors are now living on Dahl Creek and Shungnak River. On the former stream four or five cabins, several of which are now deserted, are located near the southern face of the Cosmos Hills, and on Shungnak River is a similarly located cabin. On Dahl Creek, 2 miles or so above the lower cabins, are prospectors' camps. These are the only inhabited white men's cabins in the region, but there are many others now deserted along both the Kobuk and its tributaries. Some of these deserted cabins are located as follows: Near the head of Riley Creek, near the forks of Ruby Creek, on the slopes of the valley of the left fork of Ruby Creek, on Wesley Creek, near the lower end of the canyon, on the lower part of the Kogoluktuk, and at scattered intervals along the Kobuk, the largest number at any one place being near the mouth of the Ambler.

The largest settlement of natives is, as already noted, near Shungnak, but there are also smaller settlements along the Kobuk. The largest of these is probably the one called Kalla, near the mouth of Kollyoksok River. It is impossible to give any accurate estimate of the native population, for during the summer many are away on hunting or fishing trips or go down the river to Kotzebue. Mr. Robert Samms, the missionary on Kotzebue Sound, after a careful estimate during the winter of 1898, placed the number at 500. According to the governor's report for 1910,[1] the enrollment of children at the Shungnak school during 1909 was 61, and this of course represented only a small part of the native population of even the Shungnak region.

[1] Report of the governor of Alaska for 1909, Washington, 1910, p. 20.

Most of the travel in the region is by boats during the summer and by dog teams during the winter, so that good trails are more or less lacking. However, owing to the need of communication between the mining camps and Shungnak during all seasons of the year, the United States commissioner wisely had certain prisoners build a trail from the town to the upper placer diggings on Dahl Creek. Another trail has been built from the Kobuk, near the mouth of Wesley Creek, to the mine near the forks of Ruby Creek. A boiler was taken over this trail by dog team in the winter, so it has been well leveled and brushed out, but it is not very good for summer travel. Connecting with this is a well-marked trail from Dahl Creek to Wesley Creek along the southern slopes of the Cosmos Hills.

These are the only marked trails in the region, but horses may be taken through the hills or the lowlands back from the larger streams by one experienced in Alaska travel. The Survey outfit was carried by pack animals, and it was possible to go practically at will where the work required.[1]

DESCRIPTIVE AND HISTORICAL GEOLOGY.

GENERAL STATEMENT.

Only a small part of the Shungnak region has been seen in detail, so that the description of the geology is necessarily confined to the larger subdivisions, and no attempt has been made to map more than three main groups into which the rocks and surface deposits naturally fall. These are the metamorphic rocks, both sedimentary and igneous, the Mesozoic and Tertiary (?) rocks, and the unconsolidated sands, gravels, and glacial detritus. Such a classification serves not only to differentiate the rocks on lithologic and textural grounds, but it also places them in historical order, beginning with the earliest and closing with the latest deposits. Not only are the geologic features described, but the history of the region is traced as far as the structure and lithology give insight into past conditions.

METAMORPHIC ROCKS.

The oldest rocks in the region belong to the metamorphic complex. The greatest areas of this group are in the Cosmos Hills and the Baird Mountains. In these localities several hundred square miles are underlain by these rocks. In the highlands south of the Kobuk these rocks do not occur, but they are believed to extend for several score miles north of the mapped area, and east and west they probably continue uninterruptedly from Seward Peninsula through the headwaters of the Koyukuk to the Yukon. Rocks of different

[1] The efficient and competent manner in which the Survey horses were taken through the region was due to the untiring activity and skill of the head packer, A. G. Winegarden, of Montana, to whom the writers desire to publicly express their thanks.

composition, age, and modes of origin are grouped together in this metamorphic complex, which is termed a complex mainly because so little work has been done to determine its stratigraphy rather than because it is undeterminable. Both sedimentary and igneous rocks are represented in this group. Though the former occupy a greater area, it is impossible as yet to state the relative proportion of each.

The sedimentary rocks of metamorphic character are quartzose schists, crystalline limestones, and sheared conglomerates. The quartzose schists, as their name implies, are composed mainly of quartz and mica or chlorite. They can not be distinguished by the eye from many of the rocks of Seward Peninsula. The amount of shearing and attendant metamorphism has had an important effect upon the physical character of the rocks; thus in places they are schistose, with wavy or knotted cleavage, and secondary minerals such as mica have been but sparingly developed. In this group are the black graphitic quartzose slates so commonly found in the vicinity of the productive placers in Seward Peninsula. Slates and schists of this type are found near the lower placers on Dahl Creek where the stream leaves the Cosmos Hills and on the divide between that stream and Riley and Ruby creeks. Smaller areas are also found at other places and there seems to be a rather close connection between this rock and the placers. In most places there are a great number of quartz veins and lenses in the graphitic slates and schists, ranging from microscopic filaments to masses 2 or 3 feet in width and traceable for several hundred feet along the strike. Veins of this sort are particularly numerous on the divide between Dahl and Riley creeks, and the whole hillside from the divide to the latter stream is covered with a heavy quartz float, many of the pieces weighing a hundred pounds or more.

Bluish-white crystalline limestones are closely associated with the schists of sedimentary origin. They also have been deformed, and their irregular distribution clearly indicates that they have been subjected to pronounced dislocation. It is therefore not always possible to make out with certainty their relations to the other metamorphic rocks of the region. In the area between Wesley and Ruby creeks it is certain that the limestone overlies the black slates and schists, and the same relation is shown on the central part of Dahl Creek. There is, however, a possibility that the apparent relation may have been induced by faulting, so that the stratigraphic succession may not be as suggested.

No definite information as to the age of the limestones was obtained, as fossils have been in large measure destroyed by metamorphism. In the float in the central part of Dahl Creek, not far from an outcrop of a down-faulted block of limestone, indistinct corals were found in a limestone bowlder. These were too poorly preserved to permit

specific determination but were of precisely the same appearance as fossils collected in 1909 from the limestones along the eastern flanks of the Darby Range in southeastern Seward Peninsula that were identified as Devonian and Carboniferous.[1] Another similarity between these limestones and some of those of Seward Peninsula was the strong petroliferous odor emitted when freshly broken. The limestones with these particular characteristics were dark, nearly black in color, with interlaminated bluish-white bands, the whole somewhat crystalline.

The schistose conglomerates that were observed in the region are especially developed in the southern part of the Cosmos Hills. In this locality the conglomerate occupies a strip about 2 miles wide trending in a general east-west direction and has a southward dip. Although the relations to the other metamorphic rocks are not perfectly clear, the direction of dip indicates that the conglomerates overlie the schists and slates. Further evidence in support of this interpretation is afforded by the fact that recognizable pebbles of black slate and of chloritic schist, together with numerous quartz pebbles, make up the conglomerate. These pebbles prove by their presence that schists and slates with quartz veins were in existence and had been eroded before the deposition of the conglomerate, and they suggest an unconformable relation between these rocks and the conglomerate. No pebbles of limestone were recognized, and the structure is not sufficiently definite to prove whether the limestones antedate the conglomerate or not.

On the succeeding page another conglomerate is noted, but it should be distinctly understood that the one described above and included in this section dealing with the metamorphic rocks is thoroughly sheared and schistose throughout its extent and can in no way be explained by the small amount of deformation to which the later-described conglomerate has been subjected. Not only have the pebbles composed of the softer rocks been deformed, but even the quartz pebbles have been pulled out and elongated, so that now they are many times their original length. Many pebbles 3 inches long were recognized, but this measurement, however, should not be interpreted as showing maximum distortions, for by excessive elongation the pebble form becomes more and more obliterated, so that finally it can not be recognized.

Igneous rocks that have been subjected to pronounced deformation and consequent metamorphism have also been recognized in the Shungnak region, but the exposures examined were poor. An outcrop of greenish schists belonging to this group extends for some distance along the ridge between Cosmos and Wesley creeks a mile or

[1] Smith, P. S., and Eakin, H. M., Geology of southeastern Seward Peninsula and the Nulato-Norton Bay region: Bull. U. S. Geol. Survey No. 449, 1911, p. 48.

so south of Iron Mountain. It appears to cut the underlying slate and forms a sill between that rock and the overlying limestone. So far as observed it does not cut the limestone nor does that rock show any contact effects. Metamorphism, however, has proceeded to such lengths that these criteria are not definitive. These older igneous rocks have a schistose structure, are greenish in color, and consist mainly of greenish chlorite and plagioclase feldspar, the latter as a rule completely recrystallized. They bear a close resemblance to the metamorphic greenstone schists of Seward Peninsula and are believed to have had a similar history and origin.

Taken as a whole, the metamorphic rocks show that two or possibly three periods of deposition have taken place. Two of these may have been separated by a period of metamorphism and erosion. Veins were injected prior to the deposition of the conglomerate and its subsequent metamorphism. Though it is by no means certain that there was an earlier period of metamorphism before the veins were formed, such a conclusion seems to be indicated. Igneous activity also occurred. Its extent has not been determined, but it does not seem to have been connected with the formation of valuable mineral deposits. The metamorphic rocks, with the exception of the conglomerates, seem to be mineralized and they are believed to be the ones in which deposits of metallic minerals are to be sought and from which the placers have been derived.

MESOZOIC AND TERTIARY (?) ROCKS.

A vast area south of the Kobuk, represented within the Shungnak region by the Sheklukshuk Hills, is occupied by sedimentary rocks assigned to the Cretaceous. As has already been stated, these hills have not been explored within the mapped area by members of the Survey, and as there is no description in the literature knowledge of them has been gained only by explorations east of the Shungnak region and by the long-range recognition of certain characteristics elsewhere studied in more detail. From these observations it appears that many of the higher points and a large part of the range consist of conglomerates with some sandstones, the relative proportion of the latter increasing toward the south. These beds have been folded and faulted, but in no place has schistosity of a marked character or of extensive development been seen. Emphasis is placed upon this feature because it is important in separating these newer rocks from the sheared conglomerates of the metamorphic complex.

The pebbles composing the lower part of this group have been derived from the older rocks and present a great diversity of lithology. Quartz derived from veins and lenses in the schists forms the larger number of fragments. This is probably due not so much to the abundance of the quartz in the schists as to its greater hardness,

which prevented rapid destruction. A large part of the finer material found in similar rocks farther east seems to be of volcanic origin, and the rocks contain abundant plagioclase and ferromagnesian minerals.

These more recent rocks occupy a part of the northern lowland and occur on the flanks of the bordering hills. These rocks in the lower part of the Ambler basin are described as follows by Mendenhall:[1]

> Along the lower course of the Ambler outcrops were examined which consisted of a series of conglomerates, soft cross-bedded sandstones, and shales which were often carbonaceous and carried obscure remains of plant stems. Some phases of the conglomerate are made up wholly of material derived directly from the mica schists and but little sorted. White vein quartz, somewhat rounded, furnishes most of the material for the pebbles, which are embedded in a matrix consisting chiefly of fine muscovite and chlorite foils. These beds make up the low hills between the lower Redstone and the Ambler and between the latter stream and the Kowak [Kobuk]. Similar beds associated with limestone are reported by Mr. Prindle along the middle course of Shingurk Creek [Shungnak River].

Fossils have not been found in any of these rocks within the mapped area. Mendenhall,[2] however, on the basis of their lithology and similarity to fossiliferous beds on the lower part of the Kobuk, assigned the beds in the lower part of the Ambler to the Tertiary system. In the light of the further evidence afforded by the surveys of 1909 and 1910 in the region south of the Kobuk, whereby a great Cretaceous area was outlined, it has seemed probable that these beds belong to the Mesozoic rather than to the younger era. According to this interpretation, the metamorphosed sediments on the south side of the Kobuk are part of the uninterrupted Cretaceous area that extends southward to the region beyond the mouth of Kuskokwim River and from Seward Peninsula on the west to Melozitna River on the east. The sediments in the northern lowland are considered to mark an infolded or infaulted block as the region of greater mountain-building stresses, the Baird Mountains, is approached. If, on the other hand, the younger rocks in the northern lowland are Tertiary, they may mark local basins eroded in the metamorphic and Mesozoic rocks in which later sediments have been deposited. Further investigation is needed to determine these points, but the question of age has little or no bearing upon the mineral resources.

In the region to the east igneous rocks cutting the Mesozoic and Tertiary (?) sediments have been recognized. Owing to the slight study of the later rocks in the Shungnak region no igneous rocks in place have been recorded, although they undoubtedly exist. It is highly probable that some of the unmetamorphosed basic dikes found cutting the metamorphic rocks may have been intruded during Mesozoic and Tertiary (?) time, but their upper age limit could

[1] Mendenhall, W. C., Reconnaissance from Fort Hamlin to Kotzebue Sound, Alaska: Prof. Paper U. S. Geol. Survey No. 10, 1902, p. 41.

[2] Idem, p. 42.

not be determined owing to the absence of late sedimentary beds of known age. The types of igneous rock to be expected from analogy with the more fully studied regions are basic volcanic rocks such as flows and tuffs, mainly of andesitic composition. Some granitic intrusions also have been recognized, but if the evidence afforded by the eastern part of Seward Peninsula is applicable here most of the granitic intrusions were pre-Cretaceous.

Veins are practically lacking in the Mesozoic and Tertiary (?) areas, and consequently mineral deposits requiring veins for the derivation of their valuable constituents should not be sought for in areas occupied exclusively by this group of rocks. The only economic resources likely to occur in these areas are coal beds, but, as will be shown in the section dealing with the economic geology of the region (p. 304), these resources are probably not sufficiently valuable to tempt expensive investigation.

UNCONSOLIDATED DEPOSITS.

Although the hard-rock geology is of prime importance, the placer miner is most intimately interested in the unconsolidated sands and gravels in which valuable mineral deposits may be sought. There are many different conditions under which the unconsolidated deposits were formed, and in order to understand these it is necessary to point out the recent history of the region, especially as regards the agencies. In order to do this the physiography of the region will be treated from the close of the latest period of mountain building down to the present.

TERTIARY AND RECENT HISTORY.

At the close of the last great mountain-building period, highlands trending in general east and west had been formed in the region between the Kobuk and Noatak. Probably the Mesozoic and Tertiary (?) sediments covered this range and metamorphic rocks were practically absent from the surface. Owing to the great elevation, erosion was more active in the high mountains than in the lower areas and consequently sooner removed the surficial covering. The drainage originally trended at right angles to the mountain range, and consequently the streams flowed north toward the ancient Noatak or south toward the Kobuk. The deformation, however, by no means resulted in a single anticline but was marked by several subordinate parallel ridges with intervening synclines or down-faulted areas. Each of these influenced the drainage and longitudinal valleys resulted. The northern lowland is interpreted as marking one of these constructional low areas where the Mesozoic and Tertiary (?) sediments had been relatively least elevated. The

Kobuk lowland probably marks another such area. After the drainage had been well established on this relief, valleys were eroded and the surface no longer corresponded to the constructional surface because the rivers were striving to cut their courses down and all the other processes of erosion were reducing the country to slopes appropriate to degradational processes. Thus, while the general position of the larger units of the region had been outlined by the mountain building, the present topography probably nowhere shows any vestiges of the actual surface that was produced by this process.

When the surface of the region had been carved to one somewhat remotely resembling that of the present, either a climatic or some other change capable of producing glaciation in the highland areas took place. In this period of glaciation and in the succeeding time which extends down to the present the unconsolidated deposits treated in this report were laid down. Although sands and gravels undoubtedly were deposited earlier than the period of glaciation, they have not been recognized in this region. In this report, therefore, two classes of deposits are described—first, those of glacial origin and, second, those formed after the period of glaciation, which for convenience are called stream gravels. This nomenclature is not entirely appropriate, for the glacial deposits were in many places transported by streams and have water-laid rather than ice-laid characters.

GLACIAL DEPOSITS.

During the period of maximum glaciation the ice centering in the highlands of the Baird Mountains on the north flowed down the existing valleys and covered the lowland areas. During the advance most of the former valley fillings of gravel were eroded and transported by the glaciers. The maximum extent of the glaciers has not been determined, owing to the lack not only of detailed studies but even of exploratory surveys over much of the region. Ice extended down the Kogoluktuk Valley, across the northern lowland, through the Cosmos Hills, and even into the Kobuk Valley. The Ambler Valley was also occupied by glaciers, at least as far as the Kobuk. Mendenhall [1] states:

> About 2 miles above the mouth of the Ambler River, on its left bank, occurs a deposit of blue bowlder clay 25 feet in thickness. Blocks and pebbles of dark crystalline limestone, much greenstone, and relatively small amounts of conglomerate and sandstone are scattered through the clay, and these bowlders are sometimes subangular and finely striated. The rocks of the lower course of the Ambler are sandstones and conglomerates, so that the greater part of the coarser material in the clay has been transported at least some miles. Overlying the clay are deposits about 100 feet in thickness of irregularly stratified yellow sands and clays without coarse material. The lower portion of this deposit at least is to be regarded as a true ground moraine, thus proving the extension of the Ambler Valley glacier to beyond this point.

[1] Mendenhall, W. C., op. cit., p. 48.

The proof of the extension of the Kogoluktuk Valley glacier, at least as far as the Kobuk lowland, is afforded by the distinct morainic topography of the knobs and kettles as far south as the lower cabin. No definite proof of the amount of ice in the Kobuk Valley has been obtained, but the effect on some of the streams indicates a body of ice of considerable extent. No frontal moraines of the glacier that occupied the Kobuk Valley have been recorded, although recessional moraines of the tributary streams are sharp and definite.

Attendant upon the advance of the ice was the blocking of preexisting drainage and the consequent discharge of water by unnatural channels. This continued through the period of maximum glaciation and even into the closing stages, so long as free discharge was prevented. Marking these obstructions are deposits of unconsolidated material laid down behind the ice barriers in temporary lakes or quiet water. Narrow gorges through the hills also attest the effect of past obstruction of the drainage. Except the passes of the larger streams, such as the Kogoluktuk and possibly the Shungnak, which were occupied by ice, the low passes through the Cosmos Hills were probably spillways for the impounded water that was not able to pass out by its normal course by way of the northern lowland, owing to the presence of the Ambler and the other glaciers.

Not only were deposits formed in those places where obstructions caused diversion of drainage, but even where a free discharge was permitted glacially eroded materials were deposited beyond the front of the ice. It is at present impossible to indicate just how extensive were the modifications of the topography produced by this enormous outwash of material. Without doubt much of the higher parts of the Kobuk and northern lowlands is formed of this group of deposits, though definite criteria are now unrecognizable, as the gravels have been partly transported by running water. The problems connected with the glacial occupation of the region are of importance in the search for productive placers as well as in deciphering the details which are of more purely scientific interest.

From the nature of the agency involved in gathering and transporting the materials that compose the glacial deposits, certain facts concerning the general character of these deposits may be inferred. First, owing to the lack of sorting action by glaciers during transportation deposits directly formed by glaciers generally consist of a heterogeneous collection of material unaffected by gravitative selection. Second, owing to the way a glacier acquires the materials it transports and its great erosive power, the deposits it makes are, as a whole, less weathered than those formed by rivers. The rocks are ground down or plucked bodily from the bed, so that a rock flour results from the erosion rather than a separation of the constituent rock minerals. Although the above statements apply only to deposits

formed directly by glaciers, they require but slight modifications to fit the indirect deposits formed as outwash from the front of the ice. They are, therefore, important principles which will be referred to later in discussing the possible extension of the auriferous placers (p. 298).

STREAM GRAVELS.

With the disappearance of glaciation the drainage modifications that had become established were continued and the temporary features due only to the ice occupation were abandoned. As a result channels marking short-lived discharges, now unoccupied by streams, are represented by passes such as that between Wesley and Ruby creeks or by the divide at the head of Cosmos Creek. With the development of the new drainage the streams were in some places forced to excavate part of the glacial filling of their valleys; in other places glacial erosion had deepened the valleys so that stream deposition took place; in still other places glacial modification was so slight that the streams flow almost on the preglacial surfaces.

In those stream valleys where glacial deposits have been formed and subsequently in part excavated, bowlders derived from rocks outside of the local drainage basin in which they now occur are found in the gravels, together with fragments which have not traveled so far. In the excavation of the valleys by the present streams the changed relation of the drainage is such that in many places the stream has not stopped its downcutting after incising its course through the unconsolidated deposits but has cut down into bedrock, forming a narrow gorge. In these places the gravels are relatively thin and are derived largely from the local rocks, although the harder and larger blocks from the older, higher gravels may occasionally be found. The incision of the present streams in narrow rocky gorges may be seen in many places where previous glacial filling is not indicated. Thus the Dahl Creek valley seems not to have received any such additional material from outside sources. This valley has a rocky trench near its base, in which the stream flows, and an older, more open valley above.

The unconsolidated deposits formed by these streams therefore present a great diversity of types. In one type the materials have been derived from basins outside the one in which they now occur, but although they have been transported a long way the sorting has been but slight. In another type, although the material is not of local origin, the earlier deposits have been so thoroughly rehandled by streams that considerable sorting has been effected. In still another type the unconsolidated deposits consist only of materials that have been derived from the basin in which they occur and transported and deposited only by streams. Each of these different types

can, therefore, in a measure be recognized by the size, shape, and lithology of its component materials. The recognition and the realization of the significance of the different characters presented by the different types of unconsolidated deposits are of importance to the placer miner, for certain types of deposits are more likely to contain profitable placers than others.

The physical condition of the stream gravels with respect to cementation by permanent frost has an important bearing on mining and prospecting, but the data available are not adequate for a thorough analysis of the problem. Practically all the shallow gravels are not permanently frozen. The thicker deposits, especially those in which there is a large amount of clay, and some of the bench gravels are probably frozen. In natural sections, such as occur along streams, definite evidence is not obtainable, for where the sun and air can reach the material thawing takes place. Thus a section of the gravels near the old cabin on the Kogoluktuk showed 4 feet of uncemented and unfrozen gravels overlain by 3 feet of frozen muck, which in turn was overlain by a cover of vegetation and frost litter. The upper frozen layer was so covered by the mat of vegetation which had been undermined by the river that it was protected from the sun and air, whereas the lower gravels were not.

The presence or absence of permanent frost seems to be in large measure determined by the effectiveness of subsurface drainage. Such drainage is best in well-rounded gravel deposits at an elevation above the streams and is poorest in those deposits containing a large percentage of clay or silt and lying below the level of the groundwater table. The fact that the mean annual temperature as determined from the mean of Stoney's observations (quoted on p. 277) is less than 16° F., or 16° below the freezing point, makes it possible to explain permanent frost in this region as due to existing climatic conditions.

ECONOMIC GEOLOGY.

HISTORY AND GENERAL STATEMENT.

The gold excitement which followed the Klondike discoveries caused a general influx of prospectors and others into all parts of Alaska. Every little while a new camp would be reported and a rush to the new diggings would be started. During 1898 such a stampede into the Kobuk occurred. Many of these gold seekers were unequipped for the difficulties encountered, and as they failed to find enormously rich placers they spent the winter loafing in their shacks and when reports of the rich strikes at Nome and on the Koyukuk reached them they struck out for the new fields. An account of the experiences of one of the disappointed gold seekers on the Kobuk[1]

[1] Grinnell, Joseph, Gold hunting in Alaska, Chicago, D. C. Cook Publishing Co., 1901.

gives a realistic picture of what was almost the universal condition in the region during 1898 and the early part of 1899.

With the opening of navigation in 1899 almost all the prospectors who could do so left the Kobuk and reported the region as worthless. A few prospectors have stayed with their claims and have each year taken out enough gold to live on and do a little more prospecting, buoyed up by the hope of a rich strike. It is probable that between $50,000 and $75,000 in gold has been produced since 1898. There is an enormous region to prospect, however, and with scanty means and small outfits progress has been slow. Attempts have been made, so far unsuccessfully, to interest outside men in financing different projects.

Not only have placers attracted the attention of the prospectors, but lodes of gold, copper, and silver-lead have been located and some development work done. No production has been made and there has not been enough exploitation to demonstrate satisfactorily the character or extent of the ore bodies.

The economic conditions imposed by the geographic position of the Shungnak region have exercised and must always exercise a control that will prevent working deposits which in a milder climate and in more accessible regions could be successfully mined. It is not possible to evaluate these factors, but a brief consideration of even the single item of wages may indicate the relatively high costs that must be met.

In the Shungnak region practically no white men are working for wages, so that there are no accurate data on this subject. From the fact, however, that ordinary pick and shovel miners demand $7.50 a day and board at the Squirrel River diggings, nearly 200 miles down the river, and consequently nearer civilization, there is small reason why miners in the Shungnak region should receive less. It is true that some of the placer miners pay natives $4 a day and board, but as a placer miner can work for only 60 to 80 days a year and must in that time gain sufficient to live for the other 275 days or so, $7.50 a day is by no means an excessive wage. The short season, of course, will be in part nullified if lode mines or deep placers are discovered which would give employment during the winter months. These, however, would probably not afford employment for all the miners required for open-season mining. Some decrease in living expenses is, of course, to be expected as transportation facilities are improved. As the country raises practically no foodstuffs and probably can not, it is necessary to import everything. The long distance that such supplies must be carried, the frequent handling required, and the short season available for water transportation make it improbable that any considerable reduction can be made in this item. Consequently, as these charges must be met by wages, the apparently high cost of labor must be regarded as an almost inevitable result of the isolated position of the region.

GOLD PLACERS.

From the foregoing statements concerning the number of miners in the Shungnak region, it is evident that placer mining is not carried on extensively and the production from the region is but little more than enough to pay wages to the few men employed. The main placer developments are on the streams heading in or flowing through the Cosmos Hills, namely, Dahl Creek, Shungnak River, and Riley Creek, a tributary of Kogoluktuk River. Each of these will in turn be described and the general placer resources of the region noted.

DAHL CREEK PLACERS.

Dahl Creek is a stream 7 to 8 miles long, the lower 3 miles or so of its course being through the Kobuk lowland, the middle 2 or 3 miles in a narrow rocky gorge, and the upper mile or two in a rather open valley. The placers that have been worked are located near the southern face of the Cosmos Hills and in the central part of the valley, where the junction of three small side streams with Dahl Creek has made a small flat. During the time that the Survey party was in the region no work was in progress on any of these claims, but mining had been carried on earlier in the season at both places and had been in progress for several years in the past.

The bedrock under the unconsolidated deposits here is black slate and schist with numerous small veins of quartz and in places some sulphide mineralization. The bedrock breaks into rectangular blocks of small size and the joint faces are often iron stained. The dominant strike is across the creek and thus the rocks make natural riffles for catching the gold. The slope of the bedrock surface is rather low, so that some difficulty is experienced in disposing of the tailings from mining. Near the lower group of claims schistose conglomerate outcrops but does not form bedrock under the productive placers. Limestone occurs near the placer ground in the middle part of Dahl Creek, but although float from this rock is found in the gravels it does not come down as far as the creek and does not form any of the surface on which gravel accumulation took place. Igneous rocks of a dense texture and greenish glassy color were noted upstream from the placers, but though these rocks have furnished many of the bowlders in the placer deposits they do not seem to have been connected with the mineralization and did not contribute valuable minerals to the placers.

Only the creek gravels have been mined on Dahl Creek. These average about 4 feet deep. In places they are only a foot or so thick but in others they are as much as 8 feet. Holes sunk on some of the low benches on either side of the stream have shown unconsolidated deposits 15 feet thick. Practically all the stream gravels are unfrozen, except for seasonal frost, but some of the low benches that have been prospected are reported to be permanently frozen.

The gravels in the productive placers are typical creek gravels, consisting of well-rounded pebbles with only a small amount of muck. Large, somewhat angular bowlders, most of which are of local derivation, are numerous in the gravels and cause a good deal of trouble in the mining operations. One of these large bowlders a short distance below the placers, near the southern face of the Cosmos Hills, measured 14 feet in length. It is made of the sheared conglomerate and has not been transported far. Many smaller bowlders occur directly in the auriferous gravels, however, and it is necessary to blast them out of the way.

The pay streaks differ in no essential respect from the overburden. They are usually from 1 to 2 feet in thickness and practically all the values lie in and on bedrock. The distribution of the auriferous gravels is very irregular, and it has been impossible to trace successfully any continuous pay streak. The values occur in pockets which when exhausted give no clue as to their relation to other rich spots. Such a distribution seems to indicate that values were either laid down more or less evenly and then dispersed by a change in the discharge of the creek, or else that the gold was originally deposited by a stream having strong variations in transporting ability.

Owing to the irregular distribution of the gold, statements of the value per cubic yard are of little significance. When a rich spot is found, several hundred dollars may be taken out in a few days, but at other times only a dollar or so a day can be made. Figures for the total production are also unsatisfactory, but they give a more accurate estimate of the value of the ground. The returns are not complete and probably exaggerate the amount of gold recovered, but they are an index of the size and present importance of the creek. According to the returns from the miners, in no year has Dahl Creek produced more than $10,000, and probably half this amount is nearer a correct estimate for the average production during the last six years. If this assumption is correct, not over $30,000 has been taken from this creek since its discovery.

Only a small amount of Dahl Creek gold was studied, so that a full description can not be given. The gold examined from the upstream group of placers was of a reddish to brass-yellow color. The pieces were small and some were distinctly spongy and had fairly sharp outlines, as if they had not been transported far from their place of origin. Some wire gold was also seen, but it was rare. Nuggets of considerable size have also been found in this part of Dahl Creek. One of these was seen which had a gold content worth about $65. It was a fairly well worn piece and had a considerable amount of greasy-looking milky quartz attached. Assays are reported to have shown gold value of about $16.20 an ounce.

Among the concentrates from the Dahl Creek placers magnetite is the most abundant mineral. There is also a small amount of

chromite, some of the pieces being a foot or so in diameter. Garnets are almost entirely absent. The occurrence of native silver in the concentrates has been reported and pieces nearly an inch in diameter have been examined. The silver seems to be particularly free from admixture with other metallic minerals such as copper or lead; a small amount of cadmium, however, was recognized by blowpipe examination. No evidence was procured as to the bedrock source of the silver.

Mining is done by pick and shovel methods and the gold is won by passing the gravels through sluice boxes of whipsawed lumber. Owing to the high transportation charges, machinery would be expensive to install, and owing to the character of the gravels and their tenor, few mechanical devices could be successfully operated. Short ditches provide the necessary head for sluicing, and there is almost always a sufficient water supply to meet the demand.

From the physical features of the gold and the distribution and other characters of the auriferous alluvium, it seems probable that the gold has been derived from a source within the Dahl Creek basin, especially from the areas occupied by the black slates and schists. It is believed that the source of the mineralization is the quartz veins which are so abundant in this formation.

Some prospect holes have been sunk near Dahl Creek close to the southern front of the Cosmos Hills or the northern margin of the Kobuk lowland. The returns, however, have been insufficient to warrant development and the holes have been allowed to cave, so that it was impossible to examine a section of the gravels. It was reported by prospectors that the bedrock surface slopes southward at a high angle below the lower cabins, so that shafts even 40 feet deep failed to reach bedrock. In this lower part of Dahl Creek the stream is flowing through the unconsolidated deposits of the Kobuk lowland. The absence of any shallow placers in this part of its course seems to indicate that the upper parts of the gravels of the lowland area do not contain sufficient gold to form economic deposits where subjected to the sorting of such streams as Dahl Creek.

KOGOLUKTUK RIVER.

Sparsely disseminated colors of gold have been reported from many parts of the Kogoluktuk basin, but the only stream on which placers have been mined is Riley Creek. This is a tributary from the west, heading against the Dahl Creek divide and flowing first north and then east to join the Kogoluktuk. Placer ground has been mined in a desultory way by parties of one to three men on the headwaters of this stream since 1908. Mining was in progress here when the region was visited by members of the Survey in the early part of August, 1910, but soon afterward was abandoned for the season.

The placers occur in a region of black slates, limestones, and a few intrusive igneous rocks. The bedrock is similar to that of the placers on Dahl Creek except that limestones are much more numerous. Evidences of deformation and dislocation are pronounced and the stratigraphic succession of the rocks has not been determined. Quartz veins are particularly numerous in the black slates that form the bedrock under the ground that has been worked and are believed to be closely associated with the formation of the productive placers.

In the placers typical stream gravels are practically lacking. Sections show angular slide and slightly worn unconsolidated deposits of local origin in which are irregularly distributed bowlders from outside basins. Most of these foreign bowlders are of large size and are mainly igneous rocks belonging to the group of greenstones and associated rocks. They are generally well worn and probably have been brought into their present position by the combined action of ice and water during the closing stages of the glaciation of the northern lowland. Although these greenstone bowlders are found in the placers they are in no way connected with the origin of the gold, and their distribution, except as marking former glacio-fluviatile conditions, is of no economic significance.

The gold occurs mainly in the crevices of the bedrock and in the angular unconsolidated material lying on top of the bedrock. In the part of the deposit that is mined large bowlders are less numerous than in the upper 2 or 3 feet of the deposit, but there are many bowlders even in the pay streak. The whole character of the material in which the gold is found is more like that of residual placers than that of ordinary creek placers.

The slight amount of transportation that the auriferous material has undergone is also indicated by the shape and quality of the gold. Practically all the pieces examined were sharp and angular and many had small particles of quartz attached. No large nuggets have been reported from these claims. Pieces worth as much as 50 cents were seen, and a few worth $2 to $3 were reported. The gold is bright and in an average sample the pieces were worth from one-tenth cent to 2 cents each. The individual particles are spongy and consequently appear, to one not used to the run of placer gold, to be worth much more than is actually the case. The precise assay value of the gold was not learned, but it was understood to be about $16.25 an ounce.

Accurate estimates as to the total production are not available, but from the amount of ground that has been mined during the last three years and its reported tenor it is believed that not much more than a thousand dollars a year in gold has been won.

Mining costs are high and the Riley Creek placers are unfavorably situated for economic development. The two greatest obstacles to

cheap mining are the absence of a sufficient water supply and the presence of large bowlders. The latter trouble, however, is not so serious as the lack of water, for few of the bowlders are so large that they can not be rolled back by hand or got rid of by undermining. Practically the only water available is derived from the melting snow on the northward-facing slope of the divide between Dahl and Riley creeks. Furrows parallel with the contour have been dug on the hill slope to collect the surface and shallow seepage water formed from the melting snow banks. From these furrows the water is led down the hillside and impounded behind a sod dam. Thence it is led by a short ditch and hydraulic hose to the sluice boxes. So slow is the collection of water that under favorable conditions it takes about 3½ hours to collect enough for 1½ hours' sluicing. No water, of course, can be spared for groundsluicing. Even shoveling into the sluice boxes can only be done for four or five periods a day. During wet weather the reservoir fills up more rapidly and so relatively longer periods of sluicing are possible.

After the period of sluicing and while the reservoir is refilling the miners clean away the large bowlders and get everything in readiness for the next time that the water has accumulated. The large bowlders are not cleaned but are simply rolled upon the part of the claim already worked out. In order to use the water effectively the sluice boxes are made only about half the ordinary width and were formerly set on a pitch of 1 inch in 12 inches. Subsequently, however, in order to take care of the tailings and lessen the height to which the gravels were shoveled, a pitch of 1 to 15 was adopted.

The Riley Creek placers that have been worked seem to derive their gold content from the rocks exposed in the immediate vicinity. They are so situated that they have no adequate water supply and bowlders are so numerous that the placer can be developed only at great expense. Farther downstream, where the water supply might more nearly meet the demands, thicker overlying deposits and large bowlders are probably present. The absence of especially effective sorting in this part of the basin suggests that placers will be of distinctly local importance. The whole Kogoluktuk basin, so far as indicated by the conditions on Riley Creek, seems to promise only localized placers of irregular distribution, workable as pockets rather than as extensive deposits.

SHUNGNAK RIVER.

Placer mining on Shungnak River has been carried on for a mile or so below the narrow canyon in which this stream traverses the Cosmos Hills. Work has been in progress here during the open season almost uninterruptedly since 1898. Only two or three parties of three or four men each have attempted mining during any one year, and in 1910 only one placer camp of one white man and two

or three natives was in operation. The use of native labor is an interesting experiment, and although it is reported that white men can do more work the wages paid the natives (about $4 a day and board) are so much lower that the difference in efficiency is compensated for.

Bedrock in the productive part of the river is mainly black slate and schist, but other sedimentary and igneous rocks occur at no considerable distance from the placers. Limestones occur near the head or northern end of the canyon but are not closely associated with the deposits of auriferous alluvium. The igneous rocks in proximity to the placer mines are composed mainly of serpentine, are of a dark-green color, and contain scattered particles of magnetite. These rocks have been sometimes mistaken for jade, and it is probably owing to this error that the whites have reported the name Shungnak to mean jade in the native language.

Most of the mining has been done near the southern face of the Cosmos Hills, where small flats permit turning the stream aside by wing dams. The gravels mined are generally shallow. The upper 2 feet or so is stripped off and the lower part only is put through the sluice boxes. The overburden is made up of typical river gravels with some large bowlders irregularly distributed throughout. It is not known whether the valley of Shungnak River through the Cosmos Hills was at one time occupied by ice, but it is certain that glacially eroded and transported bowlders have been brought in by glacio-fluviatile action and form part of the reworked material of the unconsolidated deposits.

The auriferous gravels are rather irregularly distributed and therefore mining has been in the nature of pocket hunting in those places where the water could be handled. The gravels are unfrozen, and in a measure this is a disadvantage, as it allows much water to seep into the pits. During high water the miners are sometimes driven out of the workings. The values are found in the lower part of the unconsolidated deposits and in the crevices of the bedrock, especially where the bedrock is black slate.

The larger part of the gold found in the placers of the Shungnak is in small pieces worth from one-half cent to 3 cents, but nuggets worth about $40 have been found, although they are by no means numerous. The gold is of a reddish color, and although not rusty it is not bright and shiny but has a dead luster. Its assay value is reported to be $16.70 an ounce. The form of the gold is very characteristic and is distinct from that of the gold from any other part of the Shungnak region, the little pieces being like shot flattened with a hammer.

Among the concentrates collected with the gold magnetite is by far the most abundant mineral. This is probably derived from the basic intrusive dikes which cut the metamorphic rocks. Garnet, or

so-called ruby, is almost entirely absent from the gravels. Small nuggets of copper and also of silver are sometimes found in the sluice boxes. Some of the silver nuggets are nearly an inch in diameter and contain but very small amounts of other metals as impurities. No clue as to the origin of the silver was obtained, but the copper nuggets were probably derived from the zone of rock impregnated with copper sulphide near the limestone-schist contact, an example of which is described in more detail on pages 300–302.

Statistics of the production from the Shungnak River placers have not been kept, and estimates prepared by interested parties are not reliable. It is improbable that the annual production amounts to more than a few thousand dollars in gold, and a liberal figure for the total production from this river would not be more than $50,000.

SUMMARY.

The amount of development and the estimated production indicate that the gold placers discovered are not extensive or highly profitable. The gold seems in general to be of local origin and this necessarily curtails the area in which productive placers may be sought to the Cosmos Hills and the Baird Mountains. The general effect of the glaciation of the region has been to disperse auriferous deposits that might previously have been formed and so destroy rather than produce commercially valuable placers. Where glacial and attendant glacio-fluviatile action did not entirely remove the auriferous deposits it undoubtedly partly eroded and transported them, and this fact probably accounts for a good deal of the irregularity of distribution. The disadvantageous economic situation due to geographic and trade conditions does not need to be discussed at length here, but these conditions are necessarily deterrent factors in the development of these placers.

LODE DEPOSITS OF METALLIC MINERALS.

At the present time no lodes have been developed to a producing stage in the region and there are very few places where even prospecting has amounted to much more than the annual assessment work stipulated by law. As is usual, much of the trouble has been due to the prospectors overburdening themselves with more claims than they could handle, so that their efforts have not been concentrated on any particular place. Consequently, so far as affording information about the lodes is concerned the prospecting has been largely valueless, and one examining the region is forced to rely mainly on natural exposures of the possible lode deposits. There are indications of mineralization at many places, but the general inaccessibility of the region and the high valuation set on many of the prospects do not invite the investment of outside capital. Without

abundant funds the developments are hampered and many of those attempted are ill directed.

GOLD LODES.

On the divide between Dahl and Riley creeks, as has already been noted, there are numerous veins in the black slates and schists. Most of these veins are small stringers, but some lenses 18 inches to 2 feet in width were noted. In one vein in particular on this divide specks of gold are reported in the quartz and a shallow prospect hole had been dug. The broken quartz from this hole had been panned and numerous small particles of gold are said to have been obtained. On the northern slopes of this ridge and continuing as far as the placers on Riley Creek there is heavy quartz float all over the surface. In many pieces of the float fine gold is visible and some containing several dollars' worth of gold are reported to have been found. The auriferous quartz from this place is mostly of a dense texture and a greasy white color. Sulphides are almost entirely absent. In this respect the veins resemble those of Seward Peninsula. In places the quartz is iron stained, but the discoloration is not present everywhere or in considerable amounts. The quartz in places shows indications of a comb structure and does not seem to have been recrystallized or badly smashed. On account of these characters it is believed that the veins from which this quartz was derived belong to a series formed later than the maximum period of regional metamorphism. This interpretation is further supported by the greater continuity of these veins as compared with those in the oldest schists of Seward Peninsula. It is believed that these quartz veins are intimately connected with the local placers on Riley Creek and that they are the sources from which the placer gold was derived.

An attempt to interest outside people in developing this gold quartz has so far proved unsuccessful. From the character of the exposures of quartz veins in the immediate vicinity it appears that the treatment of the vein material would require the handling and milling of a large amount of the country rock as well, and this would necessarily reduce the gold tenor. The question whether these veins can be worked is answerable only by careful and extensive sampling of the kind of material that must be mined and milled if the project is developed commercially. It is evident that picked specimens are absolutely worthless in arriving at the valuation, and samples of the vein material alone are likewise misleading.

There are many other places where veins similar to those at the head of Dahl Creek have been seen, and it is by no means improbable that they, too, carry some free gold, although in the hurried examination it escaped detection. These veins are more numerous in the areas occupied by the black slates, especially near the base of the limestones. This distribution appears to be dependent upon the

physical features of the slates, but the deposition of gold may have been due to chemical reactions induced by the presence of carbonaceous material throughout these rocks.

COPPER PROSPECTS.

At two places attempts have been made to prospect copper leads, but at neither place have the explorations been sufficient to determine the extent or other geologic relations of the ore. One of these projects is located on the west side of Ruby Creek about 6 miles from the junction of that stream with Shungnak River. The other lies west of the left fork of Ruby Creek, near the head of Cosmos Creek. A low limestone hill, locally known as Aurora Mountain, is the center around which the claims at the latter locality are grouped, and this name will therefore be used to designate that locality.

Copper-bearing leads on Ruby Creek have been known for many years and were critically examined in 1906 by experts in private employ to determine their commercial value. Conditions at that time prevented the purchase of the properties, and only a small amount of work has been done recently. Owing to the length of time that has elapsed since active work was in progress, many of the pits and open cuts have caved and filled to such an extent that they afford poor opportunity for examining the deposits and adjacent rocks. In this part of the Ruby Creek valley on the lower slopes there is a heavy covering of talus and vegetation, so that without pits and other sections many important facts are indeterminable.

Mineralization on Ruby Creek appears to be confined to a brecciated zone or zones in the limestones. Sulphides have been deposited in the open spaces thus formed and the ore-bearing solutions have penetrated the limestone along the many cracks and crevices and in part replaced it. There is some brecciated dolomite at the mine, and it also has been replaced and intersected by sulphides. The sulphides of economic importance are mainly bornite and chalcopyrite, but galena and iron pyrite were also noted. In the surficial part of the deposit both the blue and the green copper carbonates are common. Limonite, derived from the weathering of the pyrite, in several places forms a gossan, or "iron hat," several feet thick over the sulphide-impregnated limestone. It is reported that the weathered material when panned yields colors of gold. Average pans of the gossan from an open cut above the main workings are said to give from 1 to 3 cents in gold. Assays are said to have yielded as much as 11 per cent of copper, but no details were obtained as to the manner in which the samples were taken.

The main developments on the northernmost property consist of an adit and two open cuts. The mouth of the adit is only a few feet above the high-water level of the creek. The tunnel has been

driven about 40 feet through a much slickensided and fractured limestone, in places showing mineralization. Two short drifts, totaling only about 30 feet in length, followed especially strong indications of mineralization but evidently soon passed out of rich ore. The walls stand fairly well, but caving of the surface has so blocked the mouth of the adit that there is 12 to 18 inches of water standing on the track. A boiler was brought in from the Kobuk by way of the low pass at the head of Wesley Creek by a team of 70 dogs. When work was started a homemade mine car was used to tram the broken rock away from the working face, but a new automatic dumping car has since been installed. Wooden rails are, however, still in use. Natives have been employed as muckers and for the simpler mining operations and are said to have given satisfaction.

On the hill at an elevation of about 150 feet above the adit an open cut about 30 feet long and 10 feet or so wide had stripped the surface and had cut into the bedrock to a depth of 5 to 7 feet. Most of this pit was covered with caved surficial material so that little could be seen. The mineralization seemed to be essentially the same as that exposed in the adit. In the open cut although the bedrock is limestone it differs in some respects from that exposed in the tunnel, for none of the dolomitic phase was recognized and in places it seemed to be darker and suggested correlation with a higher horizon. However, there has been so much dislocation that the structure was not determinable and in the absence of fossils the above suggestion is to be regarded as little better than a guess.

At about the same elevation above Ruby Creek as the adit already described and 200 to 300 yards southeast of the open cut on the hill another open cut about 30 feet long has uncovered a zone of mineralization. The mode of occurrence is essentially the same as at the two other places, but only the upper weathered portion has been exposed. Copper minerals are less abundant here, but there is more limonite. Sulphides were but sparingly seen; the iron occurred mainly as oxide and the copper mainly as carbonate. It is reported that samples of the ore from this cut have a higher accessory gold content than that from either of the two other places.

About 3 miles west of the Ruby Creek copper leads is Aurora Mountain. The geologic structure at this place is essentially synclinal; brecciated and deformed limestone forming the top of the hill lies above a series of dark slates and schists that form the lower slopes. Near the contact between the two rock groups but occurring almost invariably within the limestone are indications of sulphide mineralization. The surface of the hill is so covered with frost-riven talus of limestone that except in artificial cuts the rocks are not exposed in place. Here and there copper carbonate float is found in considerable abundance.

Developments on Aurora Mountain consist mainly in finding places where the copper float is particularly abundant and then digging a hole through the overlying mantle of detritus. The only prospecting of this sort that has been carried to any considerable extent is on the northeastern slope of the hill about 300 feet above the contact of the limestone and schists. Exploration at this place at first consisted in sinking a shaft on the uphill side of a particularly conspicuous area of carbonate float. At the time this place was visited in 1910 the shaft was partly filled with water and its walls were so covered with ice that they could not be examined. It was reported that the shaft was about 22 feet deep and intersected a fairly promising copper lead about midway between the surface and the bottom. The bottom of the shaft is also said to have shown some good ore. Samples from the lower part of the shaft show bornite and chalcopyrite as well as carbonates.

Owing to the difficulty of mining the shaft was abandoned and a crosscut at about 250 feet lower elevation was commenced to connect with the deepened shaft. This adit is now in about 30 feet, and it will be necessary to extend it over 250 feet to reach a point directly underneath the shaft. Throughout its length the adit is in barren brecciated limestone, in few places showing any mineralization. Slickensiding is evident at many places, but although the amount of throw was not determined it probably was not very great, as different rocks were not brought into juxtaposition. In spite of the brecciation and faulting the rock stands well, and it has been necessary to timber only the entrance to the adit where it passes through the surface detritus.

Analyses by Thomas Price & Co.[1] of picked specimens of the bornite are reported to show 0.04 ounce of gold per ton, worth about 82 cents, and 1.4 ounces of silver per ton, worth about 91 cents, in addition to the copper content. Assays by the same analysts of chalcopyrite from Aurora Mountain yielded 0.01 ounce of gold per ton, worth about 20 cents, and a trace of silver in addition to the copper. Neither at Ruby Creek nor at Aurora Mountain, however, does the sulphide mineralization seem to have produced auriferous placers. In Ruby Creek colors of gold have been found, but at Aurora Mountain no placer gold has been reported in the stream gravels.

Although the Ruby Creek and Aurora Mountain localities are the only ones where prospecting has been carried on, there is probably similar mineralization at many other places. In fact, mineralization near the contact of certain of the limestones and schists has been recognized all the way from Seward Peninsula to this region. So far prospecting has failed to show that any of these deposits either in Seward Peninsula or in the Kobuk region are workable.

[1] Lloyd, L., unpublished letter.

Until the mode of origin and the general characters of ore bodies of this type are fully understood it seems unwise to do much dead work, such as running long crosscuts to intersect a possible ore body in depth. Even after a considerable body of ore has been disclosed a careful scrutiny of the costs of mining in this remote and rather inaccessible region should be made before expensive permanent mining machinery is installed. Although these facts should not discourage intelligent prospecting, they should serve as a warning that the search is likely to be expensive, as the cost of preliminary investigation will be high.

OTHER METALLIC RESOURCES.

Galena has been found in small quantities associated with the copper sulphides at both Ruby Creek and Aurora Mountain. A small amount of vein quartz and some brecciated and recrystallized dolomite with galena was seen near the high hill west of Wesley Creek. A shallow prospect hole has been sunk on this stringer, but so far the indications are not at all promising.

At many places magnetite in masses as much as a hundred pounds or so in weight has been found on the surface, especially near the limestone-schist contacts. Float of this sort is particularly abundant on the slopes of the sharp conical hill locally known as Iron Mountain, east of the pass between Cosmos Creek and the left fork of Ruby Creek. Specimens from this place show a nearly pure magnetite with here and there drusy cavities lined with small octahedral crystals of this mineral. As the magnetite has not been seen in place, speculation as to its origin is hardly warranted. There are no near-by igneous rocks, so it seems improbable that these bodies are due to contact-metamorphic effects. Owing to the occurrence of limonite and hematite bodies in similar limestones in the Solomon region of Seward Peninsula a tentative suggestion is that the magnetite of the Shungnak region may have been formed by the metamorphism of similar iron oxides which were laid down either contemporaneously with the inclosing limestones or earlier than the great period of dynamic metamorphism. The magnetite shows no signs of having been sheared, so it must have been either entirely recrystallized or deposited subsequent to the period of regional deformation.

Whatever theory of origin of these ores proves to be the true explanation probably matters little, for the deposits so far as known have but slight economic value. The high operating costs coupled with the absence of large ore bodies will necessarily deter capital from undertaking their development.

DEPOSITS OF NONMETALLIC MINERALS.

The geographic isolation of the Shungnak region has prevented and will probably for a long time prevent the development of any of

the nonmetallic resources except such as can be consumed near the place where they are produced. Of these resources the water supply is the one most necessary for local uses, but so far it has been little developed. If mining of gold and other metallic minerals increases in the region, this source of power may become of great value. At the present time, however, placer mining is conducted on so small a scale that either a sufficient water supply can be secured by short ditches or the claims can not afford to pay for an adequate supply.

In the Mesozoic and Tertiary (?) areas of the Sheklukshuk Hills and of the northern lowland some coal has been reported. The chances of finding deposits of sufficient value to be used at places more than a short distance from the veins seem to be poor. This opinion is based on the fact that on the Kobuk a coal bed belonging in this same series of rocks, exposed on the banks of the river and situated almost 200 miles nearer ocean transportation, has not proved commercially valuable, although attempts to mine it have been made at intervals ever since 1886. Although probably none of the coals that may be found in the Shungnak region will support extensive industry, their value for local consumption may be sufficient to warrant the search for coal in the areas of Mesozoic and Tertiary(?) rocks near productive metal mines.

Some attempts have been made to mine asbestos. This mineral is found in more or less close association with the greenstone intrusives. Several holes have been made in ledges of this rock on the east side of Dahl Creek above the upper placer mines, and samples of the asbestos have been submitted to manufacturers. It is reported, however, that the asbestos although of good color has slight tenacity, so it is not suitable for making high-grade articles and therefore commands a low price. For ordinary purposes this asbestos is well suited, but the small amount paid for this grade is not sufficient to pay the transportation charges. Furthermore, the amount so far known is small, and it would therefore be expensive to mine.

In almost all the streams of the Shungnak region north of the Kobuk bowlders of a hard green, slightly translucent rock are plentiful. These are commonly called jade, but this determination is probably incorrect. A complete examination has not been made, but some pieces are undoubtedly serpentine, others are green quartzite, and still others are probably nephrite. The last-named mineral is closely akin to jadeite but is an amphibole instead of a pyroxene and is not of gem quality. It is doubtful whether any jade of value occurs in this region, for of all the material from the Kobuk so far examined by the experts at the National Museum none was jade. Even in the so-called jade no pieces of gem quality were seen. The imperfections are due to rock cleavage and to the presence of a metallic iron mineral, probably magnetite. The cleavage causes the

mineral to split into thin layers, which makes cutting difficult and the surface flake off; the magnetite spoils the translucency and gives the stone a spotted appearance.

SUMMARY.

In concluding this report on the economic geology of the Shungnak region certain generalizations already expressed or implied seem of sufficient importance to bear repetition. At the present time the developments are on a small scale and their production is almost negligible. Prospecting has been inadequate to test the region thoroughly, but it has been commensurate with the number of men and capital available. The future of the region seems to depend more upon the auriferous deposits than upon the nonmetallic resources or the lodes of the base metals. Therefore unless placers of a type different from those now worked are found in the gravels of the lowland areas there is only a small field for prospecting and this is limited mainly to the Cosmos Hills. The geographic conditions affecting the economic future of the Shungnak region will continue to impose limitations that only especially rich deposits will be able to overcome. For these reasons, although a small and perhaps increasing production may be expected, the region as a whole does not seem to hold forth any great promise of large enterprises. It should be stated, however, that although the region may not rival the better-known camps it appears from the observations made in 1910 to have resources capable of supporting a small community, so that some prospectors and miners will find a profitable field for exploration.

THE SQUIRREL RIVER PLACERS.

By PHILIP S. SMITH.

INTRODUCTION.

During the later part of the open season of 1909 a new field of productive gold placers was discovered in the Kobuk mining district, Alaska. Although this camp is still in the early stages of development and although the production so far has been small, the promise held out to miners in this little-exploited field is attracting attention. The following observations were made in August, 1910, during a few days' visit to the new camp and are necessarily incomplete.

ROUTES AND ACCESSIBILITY OF REGION.

The productive area so far discovered is in the lower part of the Squirrel River basin.

The general position of this region with respect to better-known parts of northwestern Alaska is shown by figure 19 (p. 272). A larger-scale map of the eastern part of this field forms Plate XIII. This map is based mainly on surveys by Reaburn in 1901[1] and reports by prospectors, most notably John Tyapay, one of the original locators of Klery Creek, together with such notes as were collected during the writer's recent visit. But small cartographic precision can be claimed for this map, though the representation of the relation of the streams to one another is approximately correct. In such an undescribed region even a sketch map of this sort may be of service to the prospector and will certainly make the local nomenclature used in this paper much more easily understood.

Squirrel River is tributary to the Kobuk from the north, about 42 miles in an air line from Hotham Inlet or 60 miles from the nearest coast settlement, Kotzebue. Owing, however, to the circuitous course of the Kobuk and the approach to its mouth the distance to be traveled is 28 miles from Kotzebue to the mouth of the Kobuk and 68 miles from this point to Squirrel River, or a total of nearly 100 miles from Kotzebue. In the winter, when the region is ice-

[1] Mendenhall, W. C., Reconnaissance from Fort Hamlin to Kotzebue Sound, Alaska: Prof. Paper U. S. Geol. Survey No. 10, 1902.

U.
67
20
10'
67'
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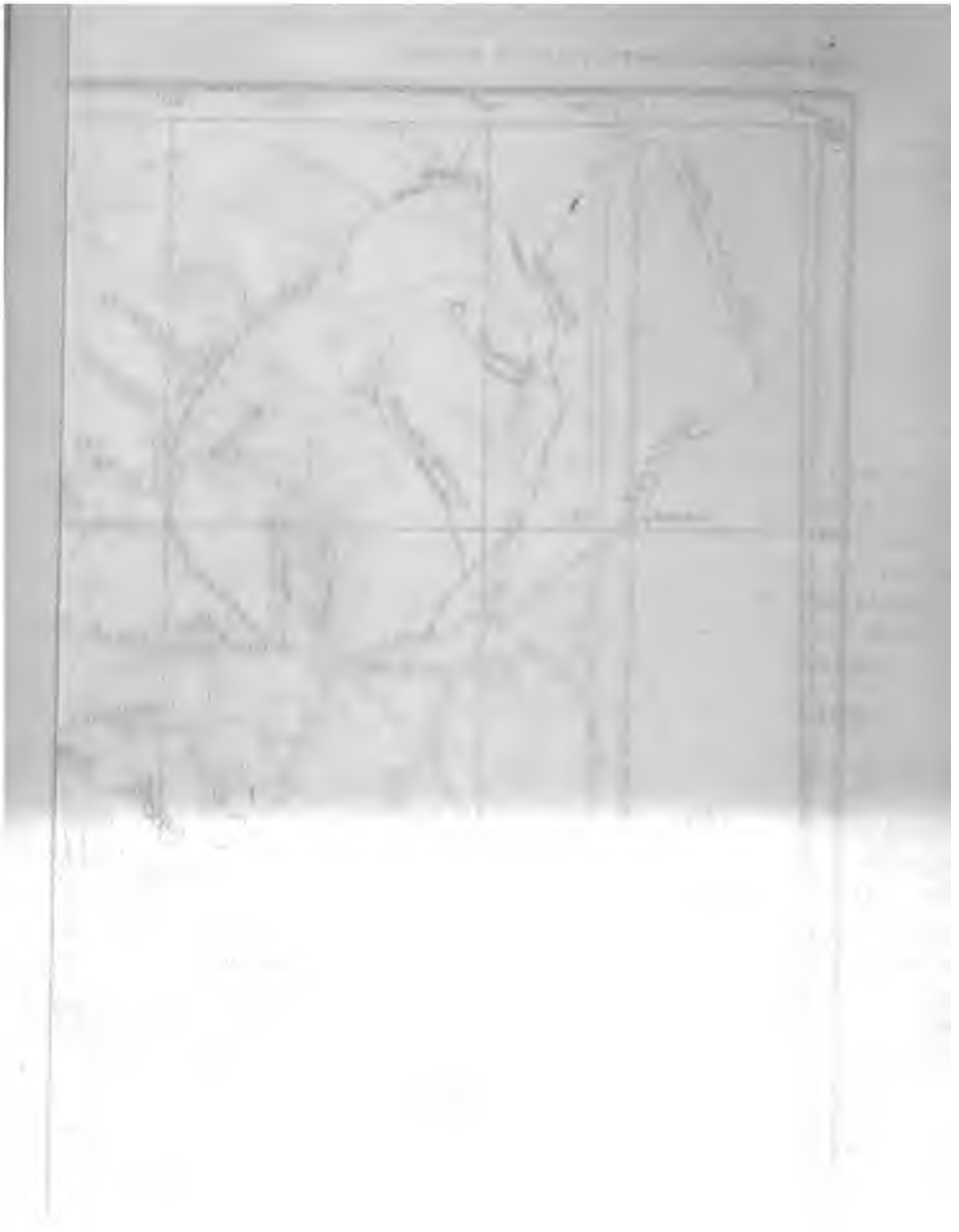

bound, access is much easier than during the summer, when countless sloughs and "niggerhead" tundra preclude overland travel.

Kotzebue is the seaport of the entire Kobuk region and is normally the home of a missionary and family, three white traders, a few boatmen and mechanics, and a small settlement of natives. After the break-up in the spring, however, missionaries, school-teachers, and prospectors, together with a great number of natives from all the neighboring rivers, congregate for trading and fishing in preparation for the coming winter, so that during July and August there are 600 to 700 people living in the town, which then stretches for more than 3 miles along the coast. A mail-boat service from Nome to this place is maintained every 10 days during the summer. The boats, however, are only 30 to 50 ton schooners with auxiliary gasoline power, and the passenger accommodations are cramped and inadequate, although the food is good. The trip from Nome by one of these boats takes about three days, as stops are made at many way points, and the charges in 1910 were $25 apiece for passengers and about $20 a ton for freight. It is not possible to use boats drawing more than 5 to 6 feet of water, as the channel up to Kotzebue is narrow, crooked, and shallow. Some larger boats from Seattle enter Kotzebue Sound, but they can not approach nearer than Cape Blossom, which is 10 to 12 miles south of the town of Kotzebue. In the winter a mail service by dog sledge once a month is maintained from Nome overland to Candle and Kiwalik and thence along the coast and on the sea ice to Kotzebue.

In the summer freight and passengers from Kotzebue for the Squirrel River diggings are transshipped to small gasoline launches or scows which draw only 2 feet of water or less and after crossing Hotham Inlet go up the Kobuk as far as the junction of Kobuk and Squirrel rivers. This trip takes from one to two days, depending on the stage of water and the load, and the charges are $15 apiece for passengers and about $15 a ton for freight. A short distance above the junction of the two streams is a small settlement formerly called Squirrel City but subsequently renamed Kiana. Here are a score or so of log cabins, a store and restaurant, and many native families engaged in fishing. It was understood that before the freeze-up two more stores were to be opened at Kiana and the recording office for the Noatak-Kobuk precinct was to be established at this place. The houses cling to the steeply incised valley walls, and there is but little drained flat land available on which the town can develop. Timber is scanty in the immediate neighborhood but can be floated down the Kobuk from points farther upstream where it is more abundant. Logs suitable for cabins were sold for a dollar a piece delivered in the water alongside the town. Water for domestic use is taken from Squirrel River and is likely to be contaminated

unless care is exercised, but no other supply is available. Prices for staple articles in 1910 were high in Kiana owing to the cost of getting supplies into the region, the loss attendant upon the many rehandlings, and the lack of active competition.

To continue the journey to the placer diggings the next stage is by small boat from Kiana up Squirrel River. The country between the river and the hills is wet and swampy, and though during high water light-draft launches can go for many miles above the settlement, ordinarily the trip can be best made by dory or other boat drawing not over 6 or 8 inches of water. By this method Squirrel River is ascended for about 7 miles to a slough which makes off toward the north and east and which at the time of the visit by the Survey geologist was so shallow near its junction with Squirrel River that the dory, containing only about 500 pounds of freight, had to be partly unloaded and hauled over the shallow riffles by men lifting on each side of the boat. Finally the slough enters a nearly round lake between one-fourth and one-half mile in diameter, which is the nearest point by water to the placer diggings. The freight charges from Kiana to this place are 2 cents a pound. Several tents had been put up on the shores of the lake by some of the miners for their own accommodations, so that a traveler could obtain shelter. From the lake it is about 7 miles over rolling slopes to the placers that are being worked, but midway there is a road house where board and lodging can be had at a dollar a meal or bed. A freighter with two horses, employed mainly by one of the mining companies, makes more or less regular trips from the lake to the diggings. The trail is over very soft ground, where even the foot traveler is most of the time half-leg deep in muck and water, but the freighter is able to carry loads of 700 to 1,000 pounds in a two-horse wagon at a rate of about a cent a mile a pound. Although horses and wagons are used on this trail, one inexperienced in the country should be warned that only a thoroughly competent driver with horses long accustomed to the peculiar and treacherous footing can successfully make the trip. Furthermore, the cost of keeping horses in the region is great, for they must be fed oats, which cost from $100 to $150 a ton.

CLIMATE.

In addition to the difficulty of reaching the region in the summer time and the high cost of transportation, the shortness of the open season exercises a marked influence on the economic problems. The entire basin of Squirrel River lies north of the Arctic Circle, so that freezing weather prevails during much of the year. According to reports the ice is seldom out of Kotzebue Sound so that Kotzebue can be reached before the middle of July, and by the middle of September the rivers are frozen; it is unsafe to count on a much later season, though there have been years when the sound near Kotzebue

was not closed before October. Therefore the open season is practically limited to two months, or about 60 days. Even during this period, however, snow and ice form. During 1910 on the night of August 15–16 ice formed on the sides of the streams and on the stagnant pools at an elevation of not more than 200 to 300 feet above the sea. On August 18 the hills around Squirrel River basin were covered with snow far down their slopes, though their tops do not reach elevations of more than 2,000 to 3,000 feet.

DRAINAGE AND RELIEF.

Little is known about the geography and geology of the Squirrel River basin. The main river probably heads against the Noatak basin on the north and the drainage into Hotham Inlet on the south. Broad flood plains traversed by sloughs and marshes occupy the lowlands from 1 to 3 miles wide on each side of the river and appear to be due mainly to the filling of a more deeply eroded older valley by thick deposits of gravel. Beyond the bottom lands the valley walls slope more or less abruptly to merge with the uplands. Even on the valley slopes, however, there are thick deposits of gravel which extend to elevations of several hundred feet above the normal level of Squirrel River. These deposits are recognizable not only in the Squirrel River basin but also for considerable distances along the Kobuk both eastward and westward.

The larger tributaries to Squirrel River, some of which are 30 to 40 miles long, in their headward portions flow on steep gradients over exposures of bedrock slightly covered with recent creek gravels. Farther down, however, benches, in part rock-cut and in part built of gravels, mark former stream levels below which the present tributaries are incised. In this portion the streams flow in rock-walled canyons, some of which are a hundred feet or more deep. Still farther downstream the creeks debouch from the hilly country and traverse the lowlands of the main river. In this part of their courses the streams are slow and have tortuous meanders and abandoned earlier channels forming sloughs that make approach difficult; no bedrock is exposed and probably it is at a considerable depth below the surface.

Little of the upland of the region was examined, so that only a most general description can be given. Viewed from a distance, however, the sky line is more or less irregular, but in general the elevations of the summits are between 2,000 and 3,000 feet. The ridges as a rule show but small undissected areas, the elevation in the main being the result of the erosive activities on the two sides of the divides. Along the summits of the higher ridges pinnacles of fantastically weathered rocks make prominent landmarks and afford excellent exposures of country rock.

VEGETATION AND GAME.

Throughout the region the vegetation is typically subarctic and arctic. All the trees show more or less stunting and the number of species is relatively few. Near the larger streams spruce forms a narrow fringe of dark green a few hundred yards in width. Few of the trees are more than a foot in diameter at the base and they taper rapidly toward the top. A few birches grow on the well-drained gravel terraces along the Kobuk, but they are not abundant in the Squirrel River basin. The white and the black birch are used as timber; the prostrate birch, which is of much wider distribution, is too small to be used even for fuel. Willow and alder are found along the smaller streams and necessarily will be an important source of fuel on many of the more remote creeks where spruce is lacking. The larger part of the basin is devoid of trees of any kind and the only vegetation on all the near-by flats and the lower hill slopes is rank grass and moss. Although the grass in places is abundant, it grows so rapidly during the long summer day and is so full of water that it does not make good feed for horses. When touched with frost, the grass seems to lose the little nourishment it had when green and stock dependent upon it rapidly lose strength.

Undoubtedly in the more remote parts of the Squirrel River basin large game, such as bear and caribou, may be found, but in the parts near the placer diggings this is not the case, and there are few indications that there has been much game in the region in the recent past. Ptarmigan and water birds, however, are abundant, and may be approached sufficiently close to obtain a considerable number, but it is believed that they are not to be entirely depended upon for food. Fish are numerous in all the streams. Salmon by the hundreds are caught in dragnets in the Kobuk and lower Squirrel River, and grayling may be had in almost all the smaller streams. So abundant are the fish that they may be safely counted on for food. The grayling will usually take either fly or bait hooks, salmon eggs on the eye of a grayling making the best bait.

GENERAL GEOLOGY.

Geologically the region presents many of the same features that are seen in parts of Seward Peninsula to the southwest. The rocks of the region, so far as known, belong in the group of metamorphic schists and limestones referred in Seward Peninsula to the Nome group. No further light was obtained as to the age of these rocks, but little hesitation is felt in assigning them to the Paleozoic or earlier periods. Schists of a variety of different characters were seen in the vicinity of the productive placers. Practically all the schists contain large amounts of chlorite, but some are dominantly quartzose and others are calcareous.

METAMORPHIC ROCKS.

The quartz schists are of two main types; one is a rather fine grained slaty schist of dark, nearly black color, with some carbonaceous material which is, in part at least, graphite; the other type is free from carbon, and the rock in fresh specimens is greenish gray, with mica or chlorite as the principal mineral observed on the cleavage surface and quartz the principal mineral observed transverse to that direction. The carbonaceous phase is lithologically similar to the Hurrah slate of the Solomon and Casadepaga region and the Kuzitrin formation of central Seward Peninsula, especially south of the Bendeleben-Kigluiak Mountains and in the southern part of the Kougarok district.

The calcareous schists, as their name implies, have a high lime content and are more or less schistose. All phases between a slightly sheared limestone and a thoroughly recrystallized schist are represented in this field. In the more schistose varieties there is an abundance of chlorite and mica flakes which increase proportionately as the lime content decreases. A yellow weathering color is in general characteristic of these calcareous schists, and topographically they do not form as prominent ridges as the limestones or some of the more quartzose schists. Some of the calcareous schists undoubtedly represent old sediments deposited contemporaneously with the sandstones which form the quartzose schists, for they appear to be interbedded with them. Some, however, are the sheared equivalents of the limestones, and these may belong to younger horizons than the quartzose schists.

Slightly sheared and metamorphosed limestones, similar in lithologic character to the thick limestones found in the vicinity of all the productive Seward Peninsula placer deposits, are recognized in the Squirrel River basin. In this district, as in the region to the southwest, these rocks make bare white hills practically devoid of vegetation, forming notable landmarks for long distances. Although minerals and structures due to dynamic deformation are developed in places throughout these limestones, the amount of metamorphism does not seem to be as great as in the quartzose schists and some of the calcareous schists. For this reason it seems probable that an unconformity exists between the heavy limestones and the metamorphic schists. This fact has not been definitely proved but seems to be indicated not only by the different amounts of metamorphism but also by the areal distribution of the limestones. No fossils have been found in the limestones of this region, and the prospector should be urged to save any traces of organisms that may be found in the rocks, as they may give a clue to many important problems.

IGNEOUS ROCKS.

In addition to the sedimentary rocks described there are also some formed by igneous agencies. These rocks are mainly the greenstones and greenstone schists. Only a few exposures of these rocks were seen, but the close similarity of the other rocks to those of Seward Peninsula suggests that probably, with more extensive study of the region, these old igneous rocks will be found to be fairly numerous. All the greenstones are more or less sheared and metamorphosed and were therefore introduced in the period preceding the great deformation of the region. None of the granites noted in parts of Seward Peninsula have been observed in this region, and there does not seem to be much probability that these more recent rocks have been injected in the neighborhood of the productive placers.

ECONOMIC GEOLOGY.

COMMERCIAL CONDITIONS.

As has already been noted, the developments in the Squirrel River region have been small, and although gold prospects are said to have been found on eight or ten tributaries of Squirrel River mining was in progress on only one of the streams, namely, Klery Creek. It is difficult to believe that this is the only place where productive placers exist, for conditions analogous to those on Klery Creek are reported at several other places in this basin. With further prospecting undoubtedly other places may be found as rich as the known ground on Klery Creek. There is, however, a strong tendency of prospectors to hold ground on a proved creek and prospect the adjacent areas only when driven to it by the exhaustion of the known ground or the inability to secure claims on a certain creek. Furthermore, the field in which placers may be expected to occur covers a large area, which takes time and money to prospect, and as yet there are but few men in the region and most of these have not enough capital to undertake any extensive exploration. At the time the region was visited by the Survey geologist there were not over 50 men in the whole region and about a third of this number were employed on one claim. Capital had not taken hold of the region, and there were few opportunities to work for wages; consequently the camps were run on a partnership basis and few of the men were equipped with the necessary supplies to carry them for a year or so of unproductive labor in building drains, etc., preparatory to opening a property. Wages were said to be $7.50 a day and board for ordinary miners, but as there was only one company employing men and as that company was able to obtain all the help it needed at $5 a day the above figures are more or less fictitious. While the labor conditions will undoubtedly change if the camp proves successful, persons should be warned

against going to Squirrel River if they have nothing but wages to depend on. In 1910 there was employment for only a few men, so that without supplies or funds the venture would be unsuccessful.

Furthermore, the usual wholesale staking of the region has tied up much of the available ground, so that unless the prospector goes to some distance from the productive creeks his chance of obtaining a claim by original location is slight. One is therefore compelled to go to a considerable distance from the proved ground or else buy or obtain a lay on a recorded claim. Any of these choices compels additional expense which the prospector should be prepared to meet. The unjustness of the system is well shown on Klery Creek, where 64 claims have been recorded above the Discovery claim and at least 20 below that point, and yet work has been done on only 10 of the claims and of these probably not more than four or five have produced a thousand dollars during the last year. This statement is not intended to discourage prospecting but only to point out the small amount of work really in progress.

PLACERS.

CREEK PLACERS.

As Klery Creek is the only stream on which mining is in progress and as two or three claims on this stream were seen in detail, a description of its placers will be given. It should be borne in mind that the general facts seen at the placers where mining is being done are to be expected in similar places throughout the field, and the facts learned by mining on one claim are helpful in the understanding of unprospected ground.

The most active work is in progress near the mouth of a small tributary, Jack Creek, a short distance above the Discovery claim. At this place there is a rock-cut gorge with a gravel-covered floor about 150 yards wide. On this floor the stream formerly followed the eastern side, but in order to allow mining the stream was turned to the other side by a roughly constructed dam. Owing to the exceptionally rainy season of 1910 the stream was abnormally high, and three times during the summer the dam was completely washed away by the floods and some of the sluice boxes with the gold in them were recovered only with difficulty. The upper 12 to 18 inches of gravel in the bed where the stream had been turned aside is removed by shoveling it aside and the larger bowlders are either rolled back upon worked-out ground or are pulled out of the way by a team of horses brought in the spring from the Inmachuk. This stripping is done rapidly and is carried down to a point where the gravels show some "sediment" or fine mud coating the pebbles and filling the interstices. None of this surface material is put through the sluice boxes, as repeated experiment has shown that it contains

practically no gold. Between the upper foot or foot and a half of gravel that is stripped off and bedrock is 12 to 18 inches of gravel in which values are obtained. These gravels are typical river wash but have been less recently handled by the stream than the upper ones. The lower gravels, together with the upper 6 inches to a foot of disintegrated bedrock, are put through the sluice boxes and it is from them that the gold is won.

Bedrock on this claim is mostly schist, but on the lower end of the claim and continuing downstream on the next adjacent claim is a massive, much-fractured, and contorted bluish-white limestone standing at a high angle and cutting transversely across the creek. The schist shows many different phases on the claim that is being mined. In part it is a dark graphitic slaty schist with numerous small veins and stringers of quartz. The bands of this schist are not more than a few feet in thickness and are interlaminated with somewhat calcareous and quartzose schists. Some of the latter schists are rusty yellow in color owing to the decomposition of some of their constituents. The iron mineral from which this limonite had been derived could not be determined, but it was probably in part pyrite. In at least one place on the claim a narrow band of limestone interlaminated with the schist was seen. From this description of the bedrock it is evident that lithologically the rocks are similar to those in the richer parts of the Nome region, in the Iron Creek basin, in the Kougarok, on Ophir and Melsing creeks near Council, in the Solomon and Casadepaga regions, and near Bluff. This resemblance is further strengthened by the relation of the schists at all these places to the heavy bluish-white limestones.

Several hundred ounces of gold from this claim was examined and the coarseness of the pieces was remarkable. Practically no fine gold was found and few if any pieces of the gold recovered were worth less than one-fourth of a cent. Several nuggets worth from $25 to $50 have been found, and while the writer was on the ground one nugget weighing nearly 7 ounces and worth about $125 was picked up in the gravel. In form the gold from this claim is chunky, or in nuggets, but a little wire gold was also seen, though no flaky or scaly gold was observed. The gold is dark but almost never black and shows few signs of recent movement. Although some of the corners have been rounded the gold as a whole does not appear to have traveled far. In fact, many pieces are sharp and angular as if but recently unlocked from the parent ledge. Some of the nuggets have pieces of the country rock still adhering to them. The most abundant mineral attached to the gold is quartz of the same physical aspect as the quartz in the strings and lenses in the schist. Black graphitic slaty schist is also attached to the gold in some of the specimens, and the way in which the gold forms filaments in this rock shows indis-

putably that some of the placer gold has been derived from this kind of country rock.

Estimates as to the value of this ground are of little use, for the nuggety character of the gold makes the tenor range between wide limits. It is reported that over 190 ounces was cleaned up from about six box lengths shortly before the visit by the Survey geologist, in 1910. At the time of the visit a clean-up of 120 ounces was made from about four and one-half box lengths. This is equal to a bedrock surface of about 500 square feet, so that the production from this cut was nearly $4.50 per square foot of bedrock. A working force of 15 men were able to strip and shovel into sluice boxes this amount of ground in a little over a day. The exact width of the pay streak is not known, for all the work so far has been only on the eastern side of the claim and the western margin of the productive ground has not been reached.

Water for sluicing is obtained from Klery Creek by running a hydraulic hose several hundred feet upstream and bringing the water thus obtained down on as flat a grade as can be maintained. This supply, however, does not furnish an adequate head, so that some other method will have to be used. But slight difficulty should be experienced in obtaining a satisfactory supply, for the volume is ample for the present demands. No accurate measurements of the volume of Klery Creek were made, but the fact that a crossing, even on a riffle, could not be made in less than 2½ feet of water, in a current of such speed that care had to be taken in keeping one's feet, shows that several thousand miner's inches is probably available during a season such as 1910. It should be noted, however, that last year was an abnormally wet one, and estimates based on observations during that time are undoubtedly above the average.

Few assays have been made of gold from this claim, but on a sample submitted to the assayer of the Nome Bank & Trust Co. a fineness of 888½ was determined. This would give a value of $18.37 an ounce.

In the concentrates collected with the gold in the sluice boxes magnetite is the most abundant mineral. This forms a much larger proportion of the concentrates than it does in those near Nome. Together with the magnetite are some ilmenite and a little pyrite and limonite. These iron minerals probably are derived mainly from the greenstones and greenstone schists, although the pyrite and its accompanying limonite may have come from veins in the schists or from the vicinity of the limestone-schist contact, a place frequently mineralized in other regions. Garnet, or so-called ruby, so commonly found in the concentrates from Seward Peninsula, is relatively rare and forms but a small proportion of the black sand. The small amount found is due to the absence of this mineral in the adjacent schists derived from

igneous and sedimentary rocks. None of the rare heavy minerals have so far been recognized in the concentrates.

About a mile and a quarter upstream from this claim is another claim, where gold similar in physical character has been found. Work on this ground has been carried on by a crew of only four men and consisted mainly of dam building and bringing up a bedrock drain, so that only a small production had been made and the opportunity of examining a large amount of gold was not afforded. It seems certain, however, that the gold from this claim is of the same chunky character as on the lower claim, although the proportion of fine gold is larger and the nuggets, as a rule, weigh less. From the shape of the gold it is believed that it has not traveled far.

Midway between these two claims the gold is of an entirely different character, although the general geology shows no marked change except that the limestone is more remote and the canyon character of the valley is more pronounced. The gold from a claim in this locality is practically all in fine bright scales. No nuggets worth more than a few cents each have been recovered, though several hundred dollars' worth of gold have been won. The scales are all nearly of the same size, no flour gold being seen. All the flakes are of a bright gold color with no tarnished nor black coating. No pieces with quartz or other foreign material attached were seen. This gold was of the type locally known to the miners as "bar" gold and showed by its physical character that it had traveled much farther from the ledge from which it was derived than the gold either upstream or downstream from this place.

Gold similar to this "bar" gold has also been found downstream from the first-described claim. It is identical in all essential respects with the one just described and has probably had a similar history. The fact that this gold has traveled farther from its parent ledge is indicated by the higher assay value of the gold. It is not possible to give its precise assay value, for the sample that was tested was mixed with nugget gold from one of the claims farther upstream. This mixed sample, however, showed a higher gold content than the nugget gold previously quoted as worth $18.37 an ounce, so the difference is probably to be assigned to the greater fineness of the "bar" gold.

ORIGIN OF THE GOLD.

The distribution of the gold and the differences in the physical character presented by this mineral from the several claims in this stretch of about 2 miles present problems of economic importance. It is believed that the coarse nuggety gold on the two claims has been derived from near-by areas of bedrock and has therefore not traveled far from its source. Possibly some of it had been concentrated in earlier stages of the valley development and was subsequently recon-

centrated in the present streams, but the movement of the gold by this process must have been relatively slight. On the other hand, the fine flaky gold found downstream from the areas of coarse gold seems to represent the smaller, lighter particles which, because of their size, have been carried farther from their source. Such a process of sorting is analogous to the well-known distribution of gold in a sluice box, where the larger, heavier particles are found toward the head end of the box and the smaller, lighter pieces near the foot or discharge end. According to this theory there are several localities of mineralization cut by Klery Creek, each being rather close to the areas of heavy gold, whereas in the intermediate regions the stream has not been so close to regions of as great mineralization and the gold has been derived from the areas upstream.

Too little is known about the region to determine beyond question whether the mineralization is confined to a single zone or whether there are a great number of mineralized zones, but from the number of places where gold has been reported in the Squirrel River basin it seems probable that there are at least several and possibly many zones of mineralization. Further study of this important question is necessary, for it affects the future of the region. Not only is it important in determining the probable area in which gold placers may be expected, but the information is also valuable in determining the trends of the placer ground. From the experience in Seward Peninsula it is believed that the contact of the heavy limestone and the graphitic or quartzose schists is one of the most favorable localities for searching for placer deposits in this group of rocks. This experience seems to be borne out in part by the work on Squirrel River, for the richest claim so far discovered has been near this contact. That there are other places where mineralization has been pronounced can not be doubted, and the prospector should therefore not place undue emphasis on the above suggestion.

BENCH GRAVELS.

So far only the shallow creek gravels in the stream beds have been exploited. There are, however, bench and high-level gravels in this region as well as the broad fillings of the main stream valleys which are possible sources of mineral wealth. None of these older gravels have been prospected as yet, and therefore suggestions as to their probable value or character are tentative and subject to revision when more information is obtained. The lower benches already noted as occurring at several different elevations above the tributary streams, such as Klery Creek, seem to have had essentially the same method of formation as the known auriferous creek gravels. It is therefore believed that where these benches have been developed in the neighborhood of bedrock mineralization they will produce placer

gold. Most of the benches of this character on Klery Creek had but small length or breadth, so that only discontinuous deposits resulted. Such benches, however, may afford rich pockets of auriferous gravel which would well repay exploitation. Many of the benches seem to be covered with muck and turf, which suggests that the gravels are frozen and will require thawing apparatus.

The higher gravels, which are of wide extent and not only cover the lower slopes of the Squirrel River basin but also extend both up and down stream along the Kobuk, present problems much more difficult to interpret. The origin of these gravels can be determined only by a general survey of a large area in the lower part of the Kobuk Valley supplemented by numerous good sections of the deposits by means of prospect shafts. The character and distribution of these high-level gravels strongly suggest that they have not been formed by normal fluviatile action. There is a possibility that they may mark marine deposition, but it seems more probable that they are the outwash deposits from ancient glaciers that at one time occupied the more eastern part of the Kobuk Valley. If this interpretation is correct, there is small probability that economically profitable placers will be found in these gravels. Although outwash deposits may contain gold, it is believed that normally the valuable minerals are so disseminated that, except under conditions of subsequent concentration, they can not be profitably extracted. These high gravel-plain deposits consist largely of rolled quartz pebbles. No striated fragments or other marks of direct glaciation were observed. The physical condition of these gravels with respect to frost is not known. As a rule, gravel deposits at any considerable elevation above the adjacent streams are so well drained that they are not permanently frozen. At several places where these gravels are exposed in the valley walls of the tributary streams there are indications that they are not frozen. These places, however, do not give conclusive evidence of the conditions of the gravels in the intermediate area between two streams, where the gravels are not exposed to the light and air and where the ground-water level rises so that the gravels are not as well drained. From the character of the surface in some of these areas which are less well drained it seems certain that permanently frozen ground will be encountered.

No prospecting has been done in the deeper gravels that form part of the flood plain of Squirrel River, so that no definite information as to the presence of placer ground there is available. It is understood that prospectors have found colors of gold on many of the bars and in shallow holes which did not reach bedrock. The ground was frozen and the necessary machinery for exploring the deposits was not at hand, so that the deep ground was abandoned for the more easily worked shallow creek diggings. From the experiences on Seward Peninsula it seems questionable whether important placer

deposits will be discovered in these flats. It should be reiterated, however, that the data for basing a decision are inadequate, and the above suggestion is little better than a guess warranted only by the desire to prevent the reckless expenditure of time and money on ill-considered projects.

SUMMARY OF CONCLUSIONS.

Taken as a whole, the Squirrel River region is one in which the small amount of prospecting already done has disclosed productive placers. The extent of these has not been determined, but it is believed that the region affords a good opportunity for industrious and capable prospectors. The rigors of the climate and the short working season are against the development of a large camp and should dissuade the incompetent from invading the new district in a "stampede." The similarity of the placers so far discovered to those in the more productive parts of Seward Peninsula gives faith in the future of the region. This belief would be further strengthened if prospecting should show the existence of valuable bench or deep deposits capable of supporting mining during the winter season. A large output in the near future is not expected, but adequate returns for intelligent and competent exploitation are indicated by the present results.

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4. Copies of all Government publications are furnished to the principal public libraries throughout the United States, where they can be consulted by those interested.

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Mining and prospecting on Prince William Sound, by U. S. Grant. In Bulletin 442, 1910, pp. 164–165.
Reconnaissance of the geology and mineral resources of Prince William Sound, Alaska, by U. S. Grant and D. F. Higgins. Bulletin 443, 1910, 89 pp.
Geology and mineral resources of the Nizina district, Alaska, by F. H. Moffit and S. R. Capps. Bulletin 448, 1911, 111 pp.

Topographic maps.

Map of Mount Wrangell; scale, 12 miles =1 inch. Contained in Professional Paper 15. Not issued separately.
Copper and upper Chistochina rivers; scale, 1:250,000; by T. G. Gerdine. Contained in Professional Paper 41. Not issued separately.
Copper, Nabesna, and Chisana rivers, headwaters of; scale, 1:250,000; by D. C. Witherspoon. Contained in Professional Paper 41. Not issued separately.
Controller Bay region special map; scale, 1:62,500; by E. G. Hamilton. For sale at 35 cents a copy or $21 per hundred.
General map of Alaska coast region from Yakutat Bay to Prince William Sound; scale, 1:1,200,000; compiled by G. C. Martin. Contained in Bulletin 335.

COOK INLET AND SUSITNA REGION.

The petroleum fields of the Pacific coast of Alaska, with an account of the Bering River coal deposits, by G. C. Martin. Bulletin 250, 1905, 64 pp.
Coal resources of southwestern Alaska, by R. W. Stone. In Bulletin 259, 1905, pp. 151–171.
Gold placers of Turnagain Arm, Cook Inlet, by F. H. Moffit. In Bulletin 259, 1905, pp. 90–99.
Mineral resources of the Kenai Peninsula; Gold fields of the Turnagain Arm region, by F. H. Moffit, pp. 1–52; coal fields of the Kachemak Bay region, by R. W. Stone, pp. 53–73. Bulletin 277, 1906, 80 pp.
Preliminary statement on the Matanuska coal field, by G. C. Martin. In Bulletin 284, 1906, pp. 88–100.
*A reconnaissance of the Matanuska coal field, Alaska, in 1905, by G. C. Martin. Bulletin 289, 1906, 36 pp.
Reconnaissance in the Matanuska and Talkeetna basins, by Sidney Paige and Adolph Knopf. In Bulletin 314, 1907, pp. 104–125.

Geologic reconnaissance in the Matanuska and Talkeetna basins, Alaska, by Sidney Paige and Adolph Knopf. Bulletin 327, 1907, 71 pp.
Notes on geology and mineral prospects in the vicinity of Seward, Kenai Peninsula, by U. S. Grant. In Bulletin 379, 1909, pp. 98–107.
Preliminary report on the mineral resources of the southern part of Kenai Peninsula, by U. S. Grant and D. F. Higgins. In Bulletin 442, 1910, pp. 166–178.
Outline of the geology and mineral resources of the Iliamna and Clark lakes region by G. C. Martin and F. J. Katz. In Bulletin 442, 1910, pp. 179–200.
Gold placers of the Mulchatna, by F. J. Katz. In Bulletin 442, 1910, pp. 201–202.
The Mount McKinley region, by A. H. Brooks, with descriptions of the igneous rocks and of the Bonnifield and Kantishna districts, by L. M. Prindle. Professional Paper 70, 1911, 234 pp.

Topographic maps.

Kenai Peninsula, northern portion; scale, 1:250,000; by E. G. Hamilton. Contained in Bulletin 277. Not published separately.
Reconnaissance map of Matanuska and Talkeetna region; scale, 1:250,000; by T. G. Gerdine and R. H. Sargent. Contained in Bulletin 327. Not published separately.
Mount McKinley region; scale, 1:625,000; by D. L. Reaburn. Contained in Professional Papers 45 and 70. Not published separately.

In press.

A geologic reconnaissance of the Iliamna region, Alaska, by G. C. Martin and F. J. Katz. Bulletin 485.

SOUTHWESTERN ALASKA.

Gold mine on Unalaska Island, by A. J. Collier. In Bulletin 259, 1905, pp. 102–103.
Gold deposits of the Shumagin Islands, by G. C. Martin. In Bulletin 259, 1905, pp. 100–101.
Notes on the petroleum fields of Alaska, by G. C. Martin. In Bulletin 259, 1905, pp. 128–139. Abstract from Bulletin 250.
The petroleum fields of the Pacific coast of Alaska, with an account of the Bering River coal deposits, by G. C. Martin. Bulletin 250, 1905, 64 pp.
Coal resources of southwestern Alaska, by R. W. Stone. In Bulletin 259, 1905, pp. 151–171.
The Herendeen Bay coal fields, by Sidney Paige. In Bulletin 284, 1906, pp. 101–108.
Mineral resources of southwestern Alaska, by W. W. Atwood. In Bulletin 379, 1909, pp. 108–152.

In press.

Geology and mineral resources of parts of Alaska Peninsula, by W. W. Atwood. Bulletin 467.

YUKON BASIN.

The coal resources of the Yukon, Alaska, by A. J. Collier. Bulletin 218, 1903, 71 pp. 15 cents.
*The gold placers of the Fortymile, Birch Creek, and Fairbanks regions, by L. M. Prindle. Bulletin 251, 1905, 89 pp. 35 cents.
Yukon placer fields, by L. M. Prindle. In Bulletin 284, 1906, pp. 109–131.
Reconnaissance from Circle to Fort Hamlin, by R. W. Stone. In Bulletin 284, 1906, pp. 128–131.
The Yukon-Tanana region, Alaska; description of the Circle quadrangle, by L. M. Prindle. Bulletin 295, 1906, 27 pp.
The Bonnifield and Kantishna regions, by L. M. Prindle. In Bulletin 314, 1907, pp. 205–226.
The Circle precinct, Alaska, by A. H. Brooks. In Bulletin 314, 1907, pp. 187–204.
The Yukon-Tanana region, Alaska; description of the Fairbanks and Rampart quadrangles, by L. M. Prindle, F. L. Hess, and C. C. Covert. Bulletin 337, 1908, 102 pp.
*Occurrence of gold in the Yukon-Tanana region, by L. M. Prindle. In Bulletin 345, 1908, pp. 179–186. 45 cents.
*The Fortymile gold-placer district, by L. M. Prindle. In Bulletin 345, 1908, pp. 187–197. 45 cents.

Water-supply investigations in Alaska, 1906 and 1907, by F. F. Henshaw and C. C. Covert. Water-Supply Paper 218, 1908, 156 pp.

*Water supply of the Fairbanks district in 1907, by C. C. Covert. In Bulletin 345, 1908, pp. 198–205. 45 cents.

The Fortymile quadrangle, by L. M. Prindle. Bulletin 375, 1909, 52 pp.

Water-supply investigations in Yukon-Tanana region, 1906–1908, by C. C. Covert and C. E. Ellsworth. Water-Supply Paper 228, 1909, 108 pp.

The Fairbanks gold-placer region, by L. M. Prindle and F. J. Katz. In Bulletin 379, 1909, pp. 181–200.

Water supply of the Yukon-Tanana region, 1907–8, by C. C. Covert and C. E. Ellsworth. In Bulletin 379, 1909, pp. 201–228.

Gold placers of the Ruby Creek district, by A. G. Maddren. In Bulletin 379, 1909, pp. 229–233.

Placers of the Gold Hill district, by A. G. Maddren. In Bulletin 379, 1909, pp. 234–237.

Gold placers of the Innoko district, by A. G. Maddren. In Bulletin 379, 1909, pp. 238–266.

The Innoko gold-placer district, with accounts of the central Kuskokwim Valley and the Ruby Creek and Gold Hill placers, by A. G. Maddren. Bulletin 410, 1910, 87 pp.

Sketch of the geology of the northeastern part of the Fairbanks quadrangle, by L. M. Prindle. In Bulletin 442, 1910, pp. 203–209.

The auriferous quartz veins of the Fairbanks district, by L. M. Prindle. In Bulletin 442, 1910, pp. 210–229.

Placer mining in the Yukon-Tanana region, by C. E. Ellsworth. In Bulletin 442, 1910, pp. 230–245.

Occurrence of wolframite and cassiterite in the gold placers of Deadwood Creek, Birch Creek district, by B. L. Johnson. In Bulletin 442, 1910, pp. 246–250.

Water supply of the Yukon-Tanana region, by C. E. Ellsworth. In Bulletin 442, 1910, pp. 251–283.

The Koyukuk-Chandalar gold region, by A. G. Maddren. In Bulletin 442, 1910, pp. 284–315.

Topographic maps.

Fortymile quadrangle; scale, 1:250,000; by E. C. Barnard. For sale at 5 cents a copy or $3 per hundred.

The Fairbanks quadrangle; scale, 1:250,000; by T. G. Gerdine, D. C. Witherspoon, and R. B. Oliver. For sale at 10 cents a copy or $6 per hundred.

Rampart quadrangle; scale, 1:250,000; by D. C. Witherspoon and R. B. Oliver. For sale at 10 cents a copy or $6 per hundred.

Fairbanks special map; scale, 1:62,500; by T. G. Gerdine and R. H. Sargent. For sale at 10 cents a copy or $6 per hundred.

Yukon-Tanana region, reconnaissance map of; scale, 1:625,000; by T. G. Gerdine. Contained in Bulletin 251, 1905. Not published separately.

Fairbanks and Birch Creek districts, reconnaissance maps of; scale, 1:250,000; by T. G. Gerdine. Contained in Bulletin 251, 1905. Not issued separately.

Circle quadrangle, Yukon-Tanana region; scale, 1:250,000; by D. C. Witherspoon. Contained in Bulletin 295. For sale at 25 cents a copy.

SEWARD PENINSULA.

A reconnaissance of the Cape Nome and adjacent gold fields of Seward Peninsula, Alaska, in 1900, by A. H. Brooks, G. B. Richardson, and A. J. Collier. In a special publication entitled "Reconnaissances in the Cape Nome and Norton Bay regions, Alaska, in 1900," 1901, 180 pp.

A reconnaissance in the Norton Bay region, Alaska, in 1900, by W. C. Mendenhall. In a special publication entitled "Reconnaissances in the Cape Nome and Norton Bay regions, Alaska, in 1900," 1901, 38 pp.

A reconnaissance of the northwestern portion of Seward Peninsula, Alaska, by A. J. Collier. Professional Paper 2, 1902, 70 pp.

The tin deposits of the York region, Alaska, by A. J. Collier. Bulletin 229, 1904, 61 pp.

Recent developments of Alaskan tin deposits, by A. J. Collier. In Bulletin 259, 1905, pp. 120–127.

The Fairhaven gold placers of Seward Peninsula, by F. H. Moffit. Bulletin 247, 1905, 85 pp.

The York tin region, by F. L. Hess. In Bulletin 284, 1906, pp. 145–157.

Gold mining on Seward Peninsula, by F. H. Moffit. In Bulletin 284, 1906, pp. 132–141.

The Kougarok region, by A. H. Brooks. In Bulletin 314, 1907, pp. 164–181.
*Water supply of Nome region, Seward Peninsula, Alaska, 1906, by J. C. Hoyt and F. F. Henshaw. Water-Supply Paper 196, 1907, 52 pp. 15 cents.
Water supply of the Nome region, Seward Peninsula, 1906, by J. C. Hoyt and F. F. Henshaw. In Bulletin 314, 1907, pp. 182–186.
The Nome region, by F. H. Moffit. In Bulletin 314, 1907, pp. 126–145.
Gold fields of the Solomon and Niukluk river basins, by P. S. Smith. In Bulletin 314, 1907, pp. 146–156.
Geology and mineral resources of Iron Creek, by P. S. Smith. In Bulletin 314, 1907, pp. 157–163.
The gold placers of parts of Seward Peninsula, Alaska, including the Nome, Council, Kougarok, Port Clarence, and Goodhope precincts, by A. J. Collier, F. L. Hess, P. S. Smith, and A. H. Brooks. Bulletin 328, 1908, 343 pp.
*Investigation of the mineral deposits of Seward Peninsula, by P. S. Smith. In Bulletin 345, 1908, pp. 206–250. 45 cents.
*The Seward Peninsula tin deposits, by Adolph Knopf. In Bulletin 345, 1908, pp. 251–267. 45 cents.
*Mineral deposits of the Lost River and Brooks Mountain regions, Seward Peninsula, by Adolph Knopf. In Bulletin 345, 1908, pp. 268–271. 45 cents.
*Water supply of the Nome and Kougarok regions, Seward Peninsula, in 1906–7, by F. F. Henshaw. In Bulletin 345, 1908, pp. 272–285. 45 cents.
Water-supply investigations in Alaska, 1906 and 1907, by F. F. Henshaw and C. C. Covert. Water-Supply Paper 218, 1908, 156 pp.
Geology of the Seward Peninsula tin deposits, by Adolph Knopf. Bulletin 358, 1908, 72 pp.
Recent developments in southern Seward Peninsula, by P. S. Smith. In Bulletin 379, 1909, pp. 267–301.
The Iron Creek region, by P. S. Smith. In Bulletin 379, 1909, pp. 302–354.
Mining in the Fairhaven precinct, by F. F. Henshaw. In Bulletin 379, 1909, pp. 355–369.
Water-supply investigations in Seward Peninsula in 1908, by F. F. Henshaw. In Bulletin 379, 1909, pp. 370–401.
Geology and mineral resources of the Solomon and Casadepaga quadrangles, Seward Peninsula, by P. S. Smith. Bulletin 433, 1910, 227 pp.
Mineral resources of the Nulato-Council region, by P. S. Smith and H. M. Eakin. In Bulletin 442, 1910, pp. 316–352.
Mining in Seward Peninsula, by F. F. Henshaw. In Bulletin 442, 1910, pp. 353–371.
Water-supply investigations in Seward Peninsula in 1909, by F. F. Henshaw. In Bulletin 442, 1910, pp. 372–418.
A geologic reconnaissance in southeastern Seward Peninsula and the Norton Bay-Nulato region, by P. S. Smith and H. M. Eakin. Bulletin 449, 1911, 146 pp.

Topographic maps.

The following maps are for sale at 5 cents a copy or $3 per hundred:

Casadepaga quadrangle, Seward Peninsula; scale, 1:62,500; by T. G. Gerdine.
Grand Central special, Seward Peninsula; scale, 1:62,500; by T. G. Gerdine.
Nome special, Seward Peninsula; scale, 1:62,500; by T. G. Gerdine.
Solomon quadrangle, Seward Peninsula; scale, 1:62,500; by T. G. Gerdine.

The following maps are for sale at 25 cents a copy or $15 per hundred:

Seward Peninsula, northeastern portion of, topographic reconnaissance of; scale, 1:250,000; by T. G. Gerdine.
Seward Peninsula, northwestern portion of, topographic reconnaissance of; scale, 1:250,000; by T. G. Gerdine.
Seward Peninsula, southern portion of, topographic reconnaissance of; scale, 1:250,000; by T. G. Gerdine.
Seward Peninsula, southeastern portion of, topographic reconnaissance of; scale, 1:250,000. Contained in Bulletin 449. Not published separately.

NORTHERN ALASKA.

A reconnaissance from Fort Hamlin to Kotzebue Sound, Alaska, by way of Dall, Kanuti, Allen, and Kowak rivers, by W. C. Mendenhall. Professional Paper 10, 1902, 68 pp.

*A reconnaissance in northern Alaska across the Rocky Mountains, along the Koyukuk, John, Anaktuvuk, and Colville rivers, and the Arctic coast to Cape Lisburne, in 1901, by F. C. Schrader and W. J. Peters. Professional Paper 20, 1904, 139 pp.

Coal fields of the Cape Lisburne region, by A. J. Collier. In Bulletin 259, 1905, pp. 172–185.

Geology and coal resources of Cape Lisburne region, Alaska, by A. J. Collier. Bulletin 278, 1906, 54 pp.

Topographic maps.

Fort Yukon to Kotzebue Sound, reconnaissance map of; scale, 1:1,200,000; by D. L. Reaburn. Contained in Professional Paper 10. Not published separately.

*Koyukuk River to mouth of Colville River, including John River; scale, 1:1,200,000; by W. J. Peters. Contained in Professional Paper 20. Not published separately.

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DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

BULLETIN 481

RESULTS OF SPIRIT LEVELING IN CALIFORNIA

1907 TO 1910, INCLUSIVE

R. B. MARSHALL, CHIEF GEOGRAPHER

WORK IN SACRAMENTO, SALINAS, AND SAN JOAQUIN VALLEYS
DONE IN COOPERATION WITH THE STATE

WASHINGTON
GOVERNMENT PRINTING OFFICE
1911

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ILLUSTRATION.

PLATE I.—Geological Survey bench marks 5

GEOLOGICAL SURVEY BENCH MARKS.

A, Tablet used in cooperating States. The State name is inserted at *G*.
B and *D*, Copper temporary bench mark, consisting of a nail and copper washer.
A, *C* and *E*, Tablets for stone or concrete structures
F, Iron post used where there is no rock.

RESULTS OF SPIRIT LEVELING IN CALIFORNIA, 1907 TO 1910, INCLUSIVE.

R. B. MARSHALL, Chief Geographer.

INTRODUCTION.

The following results of spirit leveling are supplemental to and accord with the elevations contained in Bulletin 342.

Corrections to Bulletin 342 should be noted as follows:

Page 13, Fairfield; bench mark was moved in 1911; present elevation not known.

Page 23, Chandler, add the following-described bench mark: Chandler, 0.1 mile south of, on east side of railroad, opposite milepost 106, 6 feet from track; iron post stamped "36 B 1902;" elevation, 36.227 feet.

Page 80, change description of first bench mark to read: T. 10 N., R. 19 W., near northwest corner of sec. 4, just south of point where cutoff road to Bakersfield turns west, near telephone pole 1368, 12 feet south of gate across road, 10 feet east of center of road, 2 feet south of post 6 by 8 inches; iron post stamped "1085 L. A.;" elevation, 1,086.919 feet.

Page 81, Santa Barbara; bench mark has been reestablished at northeast side of city hall, 8.5 feet southeast of northeast corner, iron post stamped "37 L. A.;" elevation, 38.007 feet.

Page 81, Santa Barbara, a new bench mark has been established, the description being as follows: Santa Barbara, city bench mark, corner De La Guerra and Anacopa streets (city elevation 32.545); U. S. G. S. elevation, 36.222 feet.

Page 85, Casmalia; bench mark described has been destroyed.

Page 100, the following should be added to the Bishop quadrangle: Laws, 6.5 miles west of, north of road, 0.5 mile west of canal; iron post stamped "4356;" elevation, 4,355.603 feet.

Page 108, Coalinga; bench mark has been moved but its elevation not materially changed.

Page 112, Fresno quadrangle; a portion of the elevations in this quadrangle have been readjusted, the corrected elevations being given in this supplement, pages 95–96.

Page 113, Kaiser quadrangle; the elevations of bench marks on this page are subject to a correction of −0.6 feet.

Page 114, the elevations of bench marks in the Kaiser quadrangle listed on this page have been changed to read as follows:

	Feet.
Bear Meadow, 0.5 mile northwest of, south of trail, on summit west of Bear Meadow, in granite ledge; bronze tablet stamped "7554 F"	7,561.109
Cassidy Meadow, south side of Rattlesnake Lake, sec. 24, T. 5 S., R. 23 E., east of granite point, in ledge between trail and lake; bronze tablet stamped "5576 F"	5,582.819

Tollhouse schoolhouse northwest along public road to power house, thence along pipe line to reservoir, thence along ditch to point 2 miles southeast of North Fork.

	Feet.
T. 10 S., R. 23 E., sec. 8, south of intersection of Pine Ridge and power house roads, in top of granite ledge; bronze tablet stamped "2013 F"	2,008.711
San Joaquin, sec. 18, T. 9 S., R. 23 E., light and power house, at northeast corner of building, in granite pillar; bronze tablet stamped "1013 F"	1,008.526
North Fork, sec. 30, T. 8 S., R. 23 E., 2 miles southeast of post office, west of road and ditch, at sharp curve above field and house, in granite bowlder 10 by 8 feet; bronze tablet stamped "2503 F"	2,498.688

Pages 117, 118, 119, Bridgeport and Mount Lyell quadrangles; the elevations on these pages, beginning with the Bridgeport quadrangle, have had a correction of approximately +4.0 feet made to them. The corrected elevations are published in this supplement, pages 102–105.

Page 127, the elevations of bench marks in the New Almaden and Santa Cruz quadrangles have been changed slightly by readjustment, and the corrected elevations are published in this supplement, pages 66, 67.

Page 139, Antioch quadrangle; elevations of the following bench marks have been changed slightly by a readjustment, and are now accepted as follows:

	Feet.
Fairfield courthouse, 2.8 miles east of, 100 feet east of water tank, on south side of road; iron post stamped "15 B"	14.670
T. 5 N., R. 1 W., southeast corner of sec. 29, 35 feet north of culvert, on east side of road to north of junction; iron post stamped "15 B" (set in 1896)	14.756
Denverton, 5 feet west of northwest corner of blacksmith shop, in front of schoolhouse; iron post stamped "7 B"	6.618

Page 140, elevations of the following-described bench marks are now accepted as follows:

	Feet.
Montezuma schoolhouse, southeast corner of yard, west of road; iron post stamped "41 B"	41.201
Willow Springs schoolhouse, southeast corner of yard, west side of road; iron post stamped "58 B"	57.738
Tolands Landing, 3 miles west of, north side of road, 1 foot south of fence line, 8 feet east of gate, 0.2 mile west of feeding shed, 100 feet north of slough; iron post stamped "10 B"	9.998
Collinsville, 0.5 mile north of, southwest corner of schoolhouse, at cross-roads; iron post stamped "5 B"	4.968

Page 142, Fairoaks quadrangle; the elevations of several of the bench marks in this quadrangle have been changed slightly. The descriptions and corrected elevations are given in this publication, pages 15–17.

Page 151, Greenwood; the elevation of this bench mark has been changed to read "198.472."

Page 152, Squaw Hill Ferry, the elevation of this bench mark has been changed to read "196.162" The elevation of United States Corps of Engineers bench mark No. 6 is 198.273 feet.

Page 153, Corning; the elevation of this bench mark has been changed by a new adjustment to read "303.335."

Pages 153 and 154, elevations of the following bench marks in the Tehama quadrangle have been changed by a new adjustment as follows:

	Feet.
Red Bluff, 6.5 miles south of, west side of road, 3 feet south of telephone pole; iron post stamped "311 B"	310.302
Red Bluff, 10.5 miles south of, west side of road, 4 feet north of telephone pole; iron post stamped "304 B"	303.349
Tehama, 5.5 miles west of, west side of road, Red Bluff at crossroads, 5 feet north of telephone pole; iron post stamped "308 B"	307.063
Cone estate, Antelope ranch headquarters, beside walk in front of residence, east side of road; iron post stamped "271 B"	270.864

Personnel.—The field work for 1907 was done under R. B. Marshall, geographer, and the later work under T. G. Gerdine, geographer, under the general direction of R. B. Marshall, chief geographer. The names of the various levelmen are given in the introduction to each list. The office work of computation, adjustment, and preparation of lists was done mainly by S. S. Gannett, geographer, and D. H. Baldwin, topographer, and since 1907 under the general direction of E. M. Douglas, geographer.

Classification.—The elevations are classified as precise or primary according to the methods employed in their determination. For precise-level lines instruments and rods of the highest grade are used, each line is run both farward and backward, and every precaution is taken to guard against error. The allowable divergence between the forward and the backward lines in feet is represented by the formula $0.017\sqrt{D}$, in which D is the distance in miles between bench marks. For primary lines standard Y levels are used; lines are run in circuits or are closed on precise lines, with an allowable closing error in feet represented by $0.05\sqrt{D}$, in which D is the length of the circuit in miles, sufficient care being given to the work to maintain this standard. For levels of both classes careful office adjustments are made, the small outstanding errors being distributed over the lines.

Bench marks.—The standard bench marks are of two forms. The first form is a circular bronze or aluminum tablet (*C* and *E*, Pl. I), 3½ inches in diameter and one-quarter inch thick, having a 3-inch stem, which is cemented in a drill hole in solid rock in the wall of some public building, a bridge abutment, or other substantial masonry structure. The second form (*F*, Pl. I), used where masonry or rock is not available, consists of a hollow wrought-iron post 3½ inches in outer diameter and 4 feet in length. The bottom is spread out to a width of 10 inches in order to give a firm bearing on the earth. A bronze or aluminum-bronze cap is riveted over the top of the post which is set about 3 feet in the ground. A third style of bench mark with abbreviated lettering (*B* and *D*, Pl. I), is used for unimportant points. This consists of a special copper nail 1½ inches in length driven through a copper washer seven-eighths inch in diameter. The tablets as well as the caps on the iron posts are appropriately lettered, and cooperation by States is indicated by the addition of the State name (*G*, Pl. I).

The numbers stamped on the bench marks described in the following pages represent the elevations to the nearest foot as determined by the levelman. These numbers are stamped with three-sixteenths-inch steel dies on the tablets or post caps, to the left of the word "FEET." The office adjustment of the notes and the reduction to

mean sea level datum may so change some of the figures that the original markings are 1 or 2 feet in error. It is assumed that engineers and others who have occasion to use the bench-mark elevations will apply to the Director of the United States Geological Survey, at Washington, D. C., for the adjusted values, and will use the markings as identification numbers only.

Datum.—All United States Geological Survey elevations are referred to mean sea level, which is the level that the sea would assume if the influence of winds and tides were eliminated. This level is not the elevation determined from the mean of the highest and the lowest tides, nor is it the half sum of the mean of all the high tides and the mean of all the low tides, which is called the half-tide level. *Mean sea level is the average height of the water, all stages of the tide being considered.* It is determined from observations made by means of tidal gages placed at stations where local conditions, such as long, narrow bays, rivers, and like features, will not affect the height of the water. To obtain even approximately correct results these observations must extend over at least one lunar month, and if accuracy is desired they must extend over several years. At ocean stations the half-tide level and the mean sea level usually differ but little. It is assumed that there is no difference between the mean sea level as determined from observations in the Atlantic Ocean, the Gulf of Mexico, or the Pacific Ocean.

The connection with tidal stations for bench marks in certain areas that lie at some distance from the seacoast is still uncertain, and this fact is indicated by the addition of a letter or word to the right of the word "DATUM" on tablets or posts. For such areas corrections for published results will be made from time to time as the precise-level lines of the United States Geological Survey or other Government organizations are extended.

Topographic maps.—Maps of the following quadrangles wholly or partly in California have been published by the United States Geological Survey up to June 10, 1911. They may be obtained (except as noted) for 5 cents each or $3 a hundred, on application to the Director of the Survey at Washington, D. C.

Alturas.
Amargosa region (Nev.-Cal.).[1] [2] (15 cents).
Anaheim.[3]
Antioch.
Arroyo Grande.[4]
Bakersfield special.
Ballarat (Cal.-Nev.).[2]
Banner Hill special.
Bidwell Bar.
Big Trees.

[1] Out of print.

[2] Amargosa region map includes Kawich sheet and parts of Ballarat, Furnace Creek, and Lida sheets.

[3] Anaheim and Santa Ana sheets, on scale of 1:62,500, have been reduced and form parts of Corona sheet, on scale 1:125,000.

[4] Arroyo Grande, Cayucos, Port Harford, and San Luis Obispo sheets, on scale of 1:62,500, have been reduced and form parts of San Luis sheet, on scale of 1:125,000.

Bouldin.
Bruceville.[1]
Calabasas.[2]
Camp Mohave (Ariz.-Nev.-Cal.).
Camulos.[2]
Capistrano.
Carbondale.[1]
Carquinez.[3]
Castle.[1]
Cayucos.[4]
Chico.
Clay.[1]
Clements.[1]
Colfax.
Colusa.
Concord.
Corona.[5]
Cosumnes.[1]
Courtland.
Cucamonga.
Cuyamaca.[6]
Dardanelles.[7]
Davisville.
Deep Creek.
Downey.
Downieville.
Dunnigan.
Elcajon.[6]
Elk Grove.[1]
Elsinore.[8]
Escondido.[9]
Fairoaks.[10]
Fernando.
Florin.[1]
Furnace Creek (Cal.-Nev.).[11]
Galt.[1]
General Grant and Sequoia national parks.[12]
Genesee special.
Goleta special.
Goose Creek.[1]
Grass Valley special.
Guadalupe.
Hawthorne.
Haywards.
Headreach.[1]
Hesperia.
Holtville.
Honey Lake.
Hueneme.
Indian Valley special.
Indio special.
Isleton.
Jackson.
Jersey.
Kaiser.
Kaweah.[12]
Kawich.[11]
Kernville.
Knights Landing.
La Jolla.
Lake Tahoe and vicinity (Cal.-Nev.).[13] [14]
(20 cents).
Las Bolsas.
Las Vegas (Nev.-Cal.).
Lassen Peak.
Lida (Nev.-Cal.).[11]
Lincoln.[10]
Linden.[1]

[1] Bruceville, Carbondale, Castle, Clay, Clements, Cosumnes, Elk Grove, Florin, Galt, Goose Creek, Headreach, Linden, Lockeford, New Hope, Waterloo, and Woodbridge sheets show Lodi quadrangle on larger scale.

[2] Calabasas and Santa Susana sheets, on scale of 1:62,500, have been reduced and form parts of Camulos sheet, on scale of 1:125,000.

[3] Carquinez sheet, on scale of 1:62,500, has been reduced and forms part of Napa sheet, on scale of 1:125,000.

[4] Arroyo Grande, Cayucos, Port Harford, and San Luis Obispo sheets, on scale of 1:62,500, have been reduced and form parts of San Luis sheet, on scale of 1:125,000.

[5] Anaheim and Santa Ana sheets, on scale of 1:62,500, have been reduced and form part of Corona sheet, on scale 1:125,000.

[6] Elcajon sheet, on scale of 1:62,500, has been reduced and forms part of Cuyamaca sheet, on scale of 1:125,000.

[7] Yosemite National Park map includes Yosemite and Mount Lyell sheets and part of Dardanelles sheet, together with that part of the park not shown on those three sheets.

[8] Riverside sheet, on scale of 1:62,500, has been reduced and forms part of Elsinore sheet, on scale of 1:125,000.

[9] Escondido and Oceanside sheets, on scale of 1:62,500, have been reduced and form parts of San Luis Rey sheet, on scale of 1:125,000.

[10] Fairoaks, Lincoln, Pleasant Grove, Roseville, and Sheridan sheets show parts of Sacramento quadrangle on larger scales.

[11] Amargosa region map includes Kawich sheet and parts of Ballarat, Furnace Creek, and Lida sheets.

[12] Sequoia and General Grant national parks map is a combination of parts of Tehipite and Kaweah sheets on same scale.

[13] Out of print.

[14] Lake Tahoe and vicinity map includes Carson, Markleeville, Pyramid Peak, and Truckee sheets.

Lockeford.[1]
Lodi.[1]
Lompoc.
Los Angeles (double sheet–10 cents).[2]
Marcuse.
Markleeville (Cal.-Nev.).[3]
Marysville.
Maxwell.
Modoc Lava Bed.
Mother Lode district special (two sheets–10 cents).
Mount Diablo.
Mount Hamilton.
Mount Lyell.[4]
Mount Pinos.
Mount Whitney.
Napa.[5]
Needles special (Ariz.-Cal.).
Nevada City special.
New Hope.[1]
Nicolaus.
Oceanside.[6]
Oil Center special (2 double sheets–20 cents).
Olancha.
Palo Alto.[7]
Parker (Ariz.-Cal.).
Pasadena.[2]
Placerville.
Pleasant Grove.[8]
Pleasanton.
Pomona.
Port Harford.[9]
Pyramid Peak.[3]
Ramona.
Randsburg.
Red Bluff.[10]
Redding.[10]
Redlands.
Redondo.
Rio Vista.
Riverside.[11]
Rock Creek.
Roseville.[8]
Sacramento.[8]
Salton Sink (photolithograph).
San Antonio.
San Bernardino.
San Diego.
San Francisco.
San Gorgonio.
San Jacinto.
San Jose.
San Luis.[9]
San Luis Obispo.[9]
San Luis Rey.[6]
San Mateo.
San Pedro.
Santa Ana.[12]
Santa Barbara special.
Santa Cruz.[7]
Santa Monica.[2]
Santa Paula.
Santa Susana.[13]
Santa Ynez.
Sequoia and General Grant national parks.[14]
Shasta.[15]
Shasta special.[15]
Sheridan.[8]

[1] Bruceville, Carbondale, Castle, Clay, Clements, Cosumnes, Elk Grove, Florin, Galt, Goose Creek, Headreach, Linden, Lockeford, New Hope, Waterloo, and Woodbridge sheets show Lodi quadrangle on larger scale.

[2] Los Angeles map includes Pasadena and Santa Monica sheets.

[3] Lake Tahoe and vicinity map includes Carson, Markleeville, Pyramid Peak, and Truckee sheets.

[4] Yosemite National Park map includes Yosemite and Mount Lyell sheets and part of Dardanelles sheet, together with that part of the park not shown on those three sheets.

[5] Carquinez sheet, on scale of 1:62500, has been reduced and forms part of Napa sheet, on scale of 1:125000.

[6] Escondido and Oceanside sheets, on scale of 1:62500, have been reduced and form parts of San Luis Rey sheet, on scale of 1:125000.

[7] Palo Alto sheet, on scale of 1:62500, has been reduced and forms part of Santa Cruz sheet, on scale of 1:125000.

[8] Fairoaks, Lincoln, Pleasant Grove, Roseville, and Sheridan sheets show parts of Sacramento quadrangle on larger scales.

[9] Arroyo Grande, Cayucos, Port Harford, and San Luis Obispo sheets, on scale of 1:62500, have been reduced and form parts of San Luis sheet, on scale of 1:125000.

[10] Redding and Tehama sheets show parts of Red Bluff quadrangle on larger scale.

[11] Rivershide sheet, on scale of 1:62500, has been reduced and forms part of Elsinore sheet, on scale of 1:125000.

[12] Anaheim and Santa Ana sheets, on scale of 1:62500, have been reduced and form parts of Corona sheet, on scale of 1:125000.

[13] Calabasas and Santa Susana sheets, on scale of 1:62500, have been reduced and form parts of Camulos sheet, on scale of 1:125000.

[14] Sequoia and General Grant national parks map is a combination of parts of Tehipite and Kaweah sheets on same scale.

[15] Shasta special sheet shows part of Shasta quadrangle on larger scale.

Sierraville.
Silver Peak (Nev.-Cal.).
Smartsville.
Sonora.
Southern California, sheet No. 1 (double sheet–10 cents).
Southern California, sheet No. 2 (double sheet–10 cents).
Southern California, sheet No. 3 (double sheet–10 cents).
Tamalpais.
Taylorsville special.
Tehama.[1]
Tehipite.[2]
Tejon.
Tesla.
Truckee.[3]
Tujunga.
Vacaville.
Ventura.
Vernon.
Vina.
Waterloo.[4]
Wellington (Cal.-Nev.).
Wheatland.
Willows.
Woodbridge.[4]
Woodland.
Yosemite.[5,6]
Yosemite National Park (25 cents).[6]
Yosemite Valley map (10 cents).[6]
Yuma (Cal.-Ariz.).

PRECISE LEVELING.

Antioch, Courtland, Davisville, and Fairoaks 15′ quadrangles; Bouldin, Isleton, Jersey, and Rio Vista 7½′ quadrangles.

SACRAMENTO, SOLANO, AND YOLO COUNTIES.

The following are the results of a precise level line run in 1907 and 1908 by L. F. Biggs from Sacramento down the Sacramento River to Fairfield, tying to bench marks previously established near those places.

The work was done in cooperation with the State.

FAIROAKS QUADRANGLE.

At Sacramento, Capitol to post office.

	Feet.
Sacramento, 300 feet east of Capitol, in top of meridian stone; aluminum tablet stamped "21 B"	20.865
Sacramento, post office building, north wall, 5 feet above ground, 15 feet east of northwest corner; aluminum tablet stamped "31 B 1905"	30.527

DAVISVILLE QUADRANGLE.

Sacramento south along west bank of Sacramento River.

Sacramento, United States Weather Bureau gage at corner of Southern Pacific freight shed, foot of L Street; nail in notch of 30-foot mark	29.519
L Street gage zero (below sea level)	−0.481
United States gage zero (below sea level)	−0.507
Southern Pacific gage zero (below sea level)	−4.861

[1] Redding and Tehama sheets show parts of Red Bluff quadrangle on larger scale.
[2] Sequoia and General Grant national parks map is a combination of parts of Tehipite and Kaweah sheets on same scale.
[3] Lake Tahoe and vicinity map includes Carson, Markleeville, Pyramid Peak, and Truckee sheets.
[4] Bruceville, Carbondale, Castle, Clay, Clements, Cosumnes, Elk Grove, Florin, Galt, Goose Creek, Headreach, Linden, Lockeford, New Hope, Waterloo, and Woodbridge sheets show Lodi quadrangle on larger scale.
[5] Yosemite Valley map shows part of Yosemite quadrangle on larger scale.
[6] Yosemite National Park map includes Yosemite and Mount Lyell sheets and part of Dardanelles sheet, together with that part of the park not shown on those three sheets.

	Feet.
Pier No. 22, Yolo County, 1 mile northwest of Broderick, on property of Valentine Hauser, 250 feet west of levee, 500 feet west of Sacramento River, on line of wire fence running east and west between two pastures; aluminum tablet in top of pier	22.230
Pier No. 22; copper bolt in base	18.538
Broderick, 3.0 miles south of, west side of road, in front of hop-storing house on Faris place; iron post stamped "B 29 1905 F 1"	28.671
Pier No. 20, Yolo County, 5 miles southwest of Broderick, on property of Pauline U. Gruhler, in corner of fence, 230 feet southeast of house, 500 feet west of Sacramento River levee; aluminum tablet in top of pier	18.725
Pier No. 20; copper bolt in base	15.080
Riverside, opposite, 300 feet south of Machardos's house, 20 feet south of road; iron post stamped "22 B 1905 F 2"	22.315

Sacramento south along east bank of Sacramento River.

Pier No. 21, Sacramento County, in outskirts of Sacramento, on property of W. W. Burler, in northwest corner of hop yard west of and adjoining Riverside Road, 30 feet from levee on east side of Sacramento River, 600 feet west from saloon of E. H. Hoppe, 0.25 mile northwest of end of electric car line, 0.5 mile south of Odd Fellows' Cemetery; aluminum tablet in top of pier	21.177
Pier No. 21; copper bolt in base	17.531
Sacramento, Southern Pacific Railroad bench mark, in base of tree at railroad crossing; spike	18.067
Pier No. 19, Sacramento County, 4 miles north of Freeport and 1.25 miles below brickyard on left bank of Sacramento River, on property of Joe Tash, 225 feet east of levee on south side of private road leading from county road to house of Joe Tash, 125 feet northeast of barn, 300 feet southwest of windmill, and 720 feet southwest of junction of county and private road; aluminum tablet in top of pier	17.806
Pier No. 19; copper bolt in base	14.128

COURTLAND QUADRANGLE.

Point near Glide Gun Club south along west bank of Sacramento River.

Glide Gun Club, 0.5 mile south of, on fence line between Glide and Content, 300 feet south of Manuel Content's house, 150 feet west of levee, 20 feet south of southwest corner of woodhouse; iron post stamped "16 B 1905 F 3"	16.012
Pier No. 18, Yolo County, 1.5 miles west of Freeport, on property of Lizzie H. Glide, near oak tree by fence on east side of property, 375 feet south of schoolhouse adjoining levee on right bank of river, and 0.25 mile east from wharf and group of buildings belonging to Lizzie H. Glide; aluminum tablet in top of pier	15.879
Pier No. 18; copper bolt in base	12.261
Freeport, 0.5 mile north of Anton Fernando's house, 40 feet from northeast corner of, west side of road, northeast corner of house lot; iron post stamped "21 B 1905 F 4"	20.852
Clarksburg, 0.5 mile north of, 100 feet east of Merritt schoolhouse, inside fence; iron post stamped "14 B 1905 F 5"	14.263
Pier No. 16, Yolo County, in town of Clarksburg, on property of Ella P. W. Smith, in south corner of pear orchard inclosed by wire fence, 375 feet southwest of Ella P. W. Smith's house adjoining levee on east side of orchard, 700 feet south of schoolhouse, 1,000 feet northwest of store and post office managed by Cave & Co.; aluminum tablet in top of pier	13.429

	Feet.
Pier No. 16; copper bolt in base	9.785
Clarksburg, gage zero below sea level	−4.382
(NOTE.—The foot graduations above 20-foot mark are numbered 1 foot too great; thus, 21 is numbered 22.)	
Clarksburg; 2.2 miles south of, 40 feet south of Ross's house, 200 feet west of Sacramento River; iron post stamped "19–1906 B N"	19.006
Courtland, 2.0 miles north of, 20 feet east of road, 150 feet west of drainage corral, 260 feet north of levee; iron post stamped "10 1906 B N"	9.900
Pier No. 14; Yolo County, 1 mile north of Courtland, on property owned by J. L. McFadden, in southwest corner of pasture inclosed by wire fence, 750 feet west of J. L. McFadden's house, 400 feet west of barn, which is 480 feet southwest of house (both buildings adjoin levee); aluminum tablet in top of pier	11.028
Pier No. 14; copper bolt in base	7.354
Grand Island, north corner of bridge abutment; aluminum tablet stamped "B 20 1906 N"	19.696
Pier No. 12, Sacramento County, Grand Island, on property of Isaac G. Hall, 0.5 mile south of Vorden, on fence line on south edge of orchard, 10 feet north of road running west from levee, 160 feet west of large frame house owned by California Transportation Co., in southeast corner of orchard at junction of road and levee, 0.25 mile south of pumping station on west bank of river; aluminum tablet in top of pier	10.337
Pier No. 12; copper bolt in base	6.723
Point near Lisbon school south along east bank of Sacramento River.	
Freeport Ferry, in front of ferryman's house, north side of road, in top of hitching post; nail	27.832
Pier No. 17, Sacramento County, 1.5 miles south of Freeport, on property of J. H. Beach, at southeast corner of storehouse, 450 feet south of vertex of angle formed by junction of railroad grade with levee, 75 feet north of house and 200 feet west of barn of J. H. Beach, 35 feet north of private road from levee through property of J. H. Beach, 125 feet northeast of junction of private road with levee; aluminum tablet in top of pier	16.301
Pier No. 17; copper bolt in base	12.583
Pier No. 15, Sacramento County, 4 miles northeast of Courtland, on property of the William Johnston estate, situated in south corner of inclosure south of and adjoining house, 200 feet south of house, 100 feet southwest of windmill, 240 feet northwest of creamery, and 185 feet from intersection of fence with levee; aluminum tablet in top of pier	12.793
Pier No. 15; copper bolt in base	9.078
Courtland; gage zero (below sea level)	−4.501
Courtland, south wall of Bauer, Miller & Newbert's store; aluminum tablet stamped "14 B 1906 N"	13.755
Pier No. 13, Sacramento County, in town of Paintersville, on property owned by Maggie V. Painter, 2 miles south of Courtland, 3 feet from south side of high board fence of corral, 30 feet east of two large oak trees standing 20 feet apart, 300 feet southeast of house of Maggie V. Painter, 140 feet east of barn on east side of levee below house, 200 feet from levee; aluminum tablet in top of pier	10.101
Pier No. 13; copper bolt in base	6.402
Vorden; gage zero (below sea level)	−5.252

	Feet.
Grand Island, 4 miles south of bridge, 250 feet southeast of E. B. King's house, 150 feet northeast of Sacramento River levee, 100 feet northeast of cross levee; iron post stamped "8 B 1906 N"	7.851
Grand Island Bridge, about 4.1 miles southeast of, 0.9 mile east of E. B. King's house, in base of tree; spike (Sacramento Southern R. R. bench mark)	12.458

BOULDIN, ISLETON, JERSEY, AND RIO VISTA 7½′ QUADRANGLES.

Point near Ryde southwest along northwest side of Sacramento River.

Pier No. 10, Sacramento County, in town of Ryde, on property of W. A. Kesner, 250 feet west of levee in northwest corner of alfalfa patch adjoining levee, 375 feet northwest of W. A. Kesner's house, 750 feet north of pumping station on south side of road near junction with levee; aluminum tablet in top of pier	7.356
Pier No. 10; copper bolt in base	3.761
Ryde; gage zero (below sea level)	−4.626
Ryde, water gage, west end of pier; 15-foot mark	10.374
Pier No. 9, Sacramento County, Andrus Island, on property of Jane Smith, 4 miles north of Isleton, at edge of open space in orchard on wire fence line, 150 feet east of intersection of levee with said wire fence which marks boundary between property of Jane Smith and George Nelson, 1,000 feet southeast of house of Jane Smith and 0.5 mile west of pumping station on Georgiana Slough; aluminum tablet in top of pier	8.965
Pier No. 11; copper bolt in base	5.246
Pier No. 8, Sacramento County, on Grand Island, on property of Stern & Co., 0.5 mile northeast of Isleton, near end of row of poplar trees running north from levee, 280 feet from junction of said row and levee, 1,000 feet northwest of house, near dividing line between property of Mrs. Buckley and that of Stern & Co.; aluminum tablet in top of pier	5.847
Pier No. 8; copper bolt in base	2.253
Rio Vista, 1.9 miles north of, 100 feet east of saloon, near ferry landing, 60 feet west of river, east side of road, in top of 6 by 6 inch timber; nail	9.269
Rio Vista, ferry; gage zero (below sea level)	−4.403
Rio Vista, water gage; spike in 16.4 foot mark	12.361
Rio Vista; gage zero (below sea level)	−4.039
Rio Vista, southeast corner of bank building, 2 feet above sidewalk; aluminum tablet stamped "23 B 1905 F 17"	22.425
Pier No. 6, Solano County, 0.3 mile south of Rio Vista, 0.3 mile west of southern end of Wood Island, just above edge of swamp in river bottom; tablet in top of pier	28.849
Pier No. 6; copper bolt in base	25.158
Rio Vista, 3.5 miles southwest of, 100 feet from southwest corner of Madison's blacksmith shop, north corner of field, east side of road; iron post stamped "B 54 1907 F 20"	53.822

Point near Walnut Grove southwest along southeast side of Sacramento River.

Pier No. 11, Sacramento County, in town of Walnut Grove, on property of Mary L. Wise, 0.5 mile north of post office; near fence on southwest side of corral surrounding barn, in line with short row of fruit trees running northeast from levee, 250 feet northeast of house near levee, 400 feet east of large oak tree on river bank, marking corner in north boundary of property of Mary L. Wise; aluminum tablet in top of pier	8.214
Pier No. 11; copper bolt in base	4.592

	Feet.
Walnut Grove; gage zero (below sea level)	−1.394
Georgiana Slough; gage zero (below sea level)	−5.829
Isleton; gage zero (below sea level)	−4.647
Ida Island, south of east end of G. F. Terschman's house, 85 feet west of, 200 feet south of Sacramento River; iron post stamped "5 B 1906 N"	4.943
Pier No. 7, Sacramento County, on Brannan Island, on property of J. Desrosier, 2 miles west of Isleton, and 0.25 mile above Rio Vista Ferry, in northeast corner of orchard, 275 feet south of levee, 225 feet south of house, 110 feet southeast of barn; aluminum tablet in top of pier	6.245
Pier No. 7; copper bolt in base	2.561

ANTIOCH QUADRANGLE.

Tolands Landing along northeast bank of Sacramento River.

Tolands Landing, summit of Blue Gum Hill, pier 4; aluminum tablet in top	119.528
Tolands Landing, summit of Blue Gum Hill, pier 4; bolt in base	115.838
Tolands Landing; 12-foot mark, United States water gage	8.292
Tolands Landing; 12-foot mark, California water gage	6.529
Stratton ranch, summit of small hill, pier 2; aluminum tablet in top	37.928
Stratton ranch, summit of small hill, pier 2; bolt in base	34.198
Collinsville; 12-foot mark, United States water gage	4.591
Collinsville; 10-foot mark, California water gage	5.508

PRIMARY LEVELING.

Fairoaks 15′ quadrangle; American, Antelope, Arcade, Brighton, Clarksville, Folsom, Mills, and Scott Ranch 7½′ quadrangles.

PLACER AND SACRAMENTO COUNTIES.

The elevations in the following list are based on the results of precise leveling along the Southern Pacific Railroad, published in Bulletin 342. Readjusted elevations are given for bench marks in the Fairoaks quadrangle.

The leveling in the Fairoaks quadrangle was done in 1901 by L. D. Ryus and in 1908 by L. F. Biggs and B. A. Jenkins, that in the American, Clarksville, Folsom, and Scott Ranch quadrangles was done in 1908 by Biggs and Jenkins. The State cooperated in the work.

FAIROAKS 15′ QUADRANGLE, INCLUDING ANTELOPE, ARCADE, BRIGHTON, AND MILLS 7½′ QUADRANGLES.

Sacramento northeast to San Juan school, thence to Fairoaks, south to Soudan, southwest along Southern Pacific Railroad to Routier, south to Walsh station, and northwest along Southern Pacific Railroad to Brighton.

	Feet.
Sacramento, 3 miles northeast of State Capitol, at intersection of roads; iron post stamped "39 B"	39.320
Ben Ali, 2.5 miles east of, 150 feet west of windmill, at intersection of roads; iron post stamped "69 B"	68.576
San Juan schoolhouse, 1 mile east of, southeast corner of field, at intersection of roads; iron post stamped "191 B"	190.625
Fairoaks Junction, 300 feet east of switch, at southeast corner of field, north of track; iron post stamped "113 B"	112.973

	Feet.
Routier, opposite station, north of county road; iron post stamped "69 B"..	68.826
Walsh, at southwest corner of field, opposite saloon; iron post stamped "64 B".....	64.043

Sacramento north along Marysville road to forks of road at northwest corner of sec. 19, T. 10 N., R. 5 E., thence east to quarter corner on south side of sec. 10, T. 10 N., R. 6 E., thence south to Fairoaks.

Sacramento, 5 miles north of capitol, 250 feet north of house, 100 feet west of corner at L of road; iron post stamped "28 B".....	27.933
T. 10 N., R. 5 E., northwest corner of sec. 19, at intersection of road running east from main road; iron post stamped "31 B".....	30.862
T. 10 N., R. 5 E., southwest corner of sec. 13, 1 mile south of Center Union schoolhouse, east side of road, at angle to north; iron post stamped "89 B".....	88.951
Antelope, 2 miles northeast of, at edge of Southern Pacific Railroad right of way, north of road at crossing, west of track; iron post stamped "146 B"	146.130
T. 10 N., R. 6 E., near center of sec. 26, southeast corner of Sylvan schoolhouse yard at crossroads; iron post stamped "151 B.".....	151.212

Forks of road 2.6 miles east of Riego south to center line of T. 10 N., thence east 2.25 miles to Fork road near Dry Creek, thence south and southwest to Sacramento.

Roseville, 8.6 miles west by 2.6 miles south of, in southwest angle of crossroads, 0.25 mile east of southeast corner of sec. 16, T. 10 N., R. 5 E., 1,000 feet south of white house, in fence corner; iron post stamped "61–R"..	61.262
Dry Creek, 0.4 mile west of, west of road, between secs. 14 and 23, T. 10 N., R. 5 E., at grove of oaks, in base of 36-inch oak tree, 60 feet west of second-class road; spike; with aluminum tag stamped "74–84".....	74.91
Sacramento, 9 miles northeast of, east of road through Haggan grant; iron post stamped "66 B 1908 S. B.".....	67.007
Sacramento, 8.2 miles northeast of, south bank of small creek, east of road through grant, in base of 10-inch cottonwood tree; spike; aluminum tag stamped "53 87".....	53.38
Sacramento, 5.6 miles northeast of, east of road, at road junction, 50 feet east of gate to ranch house, at fence corner; iron post stamped "50, B. T., 1908, B".....	50.673
Sacramento, 3.2 miles north of, east of road, at road junction, 20 feet south of fence corner; iron post stamped "39 B".....	39.240
Sacramento, 2.4 miles north of, east of road, at fence line, 0.25 mile north of bridge; iron post stamped "U. S. E. D. B. M. 10 33.5".....	29.925
Sacramento, 1.6 miles north of, north of road, 400 feet north of N. E. R. R. crossing; iron post (United States Corps of Army Engineers,[1] B. M. 8, elev. 28.5).....	24.991

Point near Sylvan school southwest 3.5 miles, thence northwest 4 miles to fork 2.8 miles northwest of Wanega station.

Sylvan school, sec. 26, T. 10 N., R. 6 E., 2.4 miles southwest of, south of road, opposite Twelvemile House, 25 feet south of southeast corner of porch of hotel; iron post stamped "108 B 1908 B. V.".....	108.900
Wanega, 700 feet east of station, west of right of way, 35 feet west of milepost 101, at fence line; iron post stamped "107 B 1908 U. B.".....	107.106

[1] Locally known as U. S. Engineer Department.

Roseville south and east 3 miles (part of line to Orangevale).

	Feet.
Roseville, 0.4 mile south of, bridge over creek, in top of floor; spike painted "150 98"	150.08

Riego south 2.7 miles to Fork road, thence east 2 miles.

Riego, 1.3 miles south of, north of road, in top of granite post on county line; aluminum tablet stamped "37 B 1908 B. D. 1"	37.551
Sixmile House, 3.5 miles north of, at intersection of road running east from main road; iron post stamped "31 B"	30.862

Point 5.6 miles northeast of Sacramento east via Arcade to point 3.5 miles east of Ben Ali, thence south to vicinity of Del Paso and west to forks of road 2.4 miles northeast of Sacramento and 0.25 mile northeast of bridge over American River.

Sacramento, 5.6 miles northeast of, east of road, at road junction, 50 feet east of gate to ranch house at fence corner; iron post stamped "50 B 1908 B. T."	50.673
Ben Ali, 2.5 miles east of, 150 feet west of windmill at intersection of roads; iron post stamped "69 B"	68.576
Del Paso, 2.4 miles north of, at road crossing, 60 feet northwest of oak tree, 20 feet south of road; iron post stamped "94 B 1908 B. T. 1"	93.865
Del Paso, 0.25 mile west of, at junction of roads, 25 feet west of gate to headquarters of ranch, at telephone pole; iron post stamped "90 B 1908 U. 1".	91.030
Del Paso, 2.2 miles west of, west of road, at gate and junction of road; iron post stamped "44 B 1908 B. V. 1"	43.950
Del Paso, 5.7 miles west of, west of Southern Pacific Railroad, 40 feet east of gate, near telephone pole at fence line; iron post stamped "30 B 1908 B. W. 1"	30.405

Twelvemile House east 1 mile, thence north 3.5 miles and west and south to Walsh.

Twelvemile House, 1 mile east by 3.5 miles north of, at southwest angle of fork of roads; iron post stamped "B 1908 133 1"	133.105
Brighton school, 0.5 mile south of, west of road, north of fork road to west; iron post stamped "68 B 1908 2"	67.832

Sacramento south 4.3 miles, thence east to Walsh.

T. 8 N., R. 5 E., southwest corner of sec. 19, southwest angle of crossroads; iron post stamped "24 B 1908 3"	23.936
T. 8 N., R. 5 E., south side of sec. 21, southeast angle of intersection with upper Stockton road, opposite road house; iron post stamped "30 B 1908 4"	29.820
T. 8 N., R. 5 E., southeast corner of sec. 23, at northwest angle of crossroads; iron post stamped "42 B 1908 5"	42.409

Bench marks in vicinity of Fairoaks.

Fairoaks, 0.7 mile east of, southwest corner of bridge, on concrete; chiseled circle painted "U. S. B. M."	151.17
Fairoaks, 400 feet north of store, in center of road corner, in notch in base of 50-inch oak tree; nail with aluminum tag stamped "181 35"	180.78
Fairoaks, bridge over American River, in west face of south concrete pier; aluminum tablet stamped "89 B 1908 16"	88.603
Fairoaks, in front of railroad station; top of rail	104.81

AMERICAN, CLARKSVILLE, FOLSOM, AND SCOTT RANCH 7½′ QUADRANGLES.

Point 1.8 miles northwest of Slough House.

	Feet.
Slough House, 1.8 miles northwest of, where Grant Line road intersects Sacramento-Jackson road; iron post stamped "150 B 1907 30"	150.652

Forks of road 1 mile east by 3.5 miles north of Twelvemile House east to Bridge House, on Folsom road.

Twelvemile House, 4.5 miles east by 3 miles north of, east of road, at angle; iron post stamped "201 B 1908 6"	200.625
Twelvemile House, 8 miles east by 3 miles north of, on summit, 0.5 mile west of ranch house; iron post stamped "250 B 1908 7"	250.12

Bridge House north to Folsom.

Scott ranch, 2.2 miles south of, on Sacramento-Latrobe road, at gate to private road from south; iron post stamped "184 B 1908 9"	184.400
Scott ranch, 1.6 miles south of, 20 feet west of road, 0.4 mile north of angle in road, in notch in base of 36-inch oak tree; nail with aluminum tag stamped "206 22"	206.02
Scott ranch, 1 mile north of, 60 feet west of road, in large bowlder; tablet stamped "198 B 1908 8"	197.993
Scott ranch, 1.7 miles north of, 200 feet north of private road from west, east of road, in notch in root of 48-inch oak tree; nail scribed and painted "U. S. B. M. 211 20"	210.96
Scott ranch, 3.6 miles north of, 100 feet south of big bridge, at east edge of road, in ledge; aluminum tablet stamped "225 1908 B 11"	225.423
Folsom, 5 miles south of, 100 feet east of intersection of roads, in center of road; point on large bowlder painted "U. S. G. S. B. M. 341 25"	341.57
Folsom, 3 miles south of, 60 feet south of Alder Creek bridge, at east edge of road; iron post stamped "237 B 1908 12"	237.467
Folsom, northeast corner of Catholic Church lot; iron post stamped "224 B 1908 13"	223.998
Folsom, in front of station; top of rail	193.5

Folsom west to Fairoaks.

Orangevale, 0.5 mile west by 2 miles south of, at intersection of roads; iron post stamped "246 B 1908 15"	246.043
Fairoaks, 2.9 miles northeast of, northwest angle of crossroads, in notch in base of 15-inch oak tree; nail with aluminum tag stamped "249 32"	248.81

Folsom southwest along road via Natoma to Salisbury.

Folsom, 100 feet east of bridge over American River, in top of large flat bowlder; aluminum tablet stamped "162 B 1908 14"	162.109
Folsom, 0.7 mile west of, north of road, at fence line (U. S. Corps of Engineers[1] bench mark "58 1885")	185.01
Folsom, U. S. Corps of Engineers bench mark No. 57	180.804
Folsom, 3.3 miles west of, north of road, at fence line; iron post stamped "167 7 B. M. 51" (U. S. Corps of Engineers bench mark No. 51)	164.182
Folsom, 3.5 miles west of, stone bridge over Alder Creek, southeast corner of granite guard; aluminum tablet stamped "155 B 1908 B. A. 1"	155.374

[1] Locally known as U. S. Engineer Department.

	Feet.
Natoma, 0.7 mile west of, south of road, at fence line; iron post stamped "139 7 B. M. 43" (U. S. Corps of Engineers bench mark No. 43).....	136.179
Natoma, 1.7 miles west of, south of road, at fence line; iron post stamped "127 3 B. M. 41" (U. S. Corps of Engineers bench mark No. 41).....	123.787
Natoma, 2 miles west of, southeast corner of bridge over Buffalo Creek, top of granite guard; aluminum tablet stamped "129 B 1908 B. B. 1"..	129.162

Point near Roseville east and south to Orangevale.

Roseville, 0.4 mile south by 1.9 miles east of, south of road, at fence line, on bowlder; chisel point painted "237 B. M. 100".....	237.11
Orangevale, 5.5 miles north of, south of road junction, in fence corner; iron post stamped "236 B 1908 B. Y.".....	235.708
Orangevale, 4 miles north of, at junction of road, 50 feet south of bridge at fence corner, in base of 24-inch oak tree; spike with aluminum tag stamped "195 B. M. 102".....	195.32
Orangevale, 2.5 miles north of, east of road, at junction, in fence corner, 500 feet south of white house; iron post stamped "203 B 1908 B. Z.".....	203.293

Courtland 15′ quadrangle; Bouldin, Isleton, Jersey, and Rio Vista 7½′ quadrangles.

CONTRA COSTA, SACRAMENTO, SAN JOAQUIN, SOLANO, AND YOLO COUNTIES.

The elevations in the following list are based on the results of precise leveling along the Southern Pacific Railroad and along the Sacramento River, and accord with the results published in Bulletin 342.

The leveling was done in 1905 by R. A. Farmer, in 1906 by C. L. Nelson, and in 1908 by B. A. Jenkins in cooperation with the State.

COURTLAND 15′ QUADRANGLE.

Tremont east 4 miles, thence south 6.5 miles, east 2 miles, south 3 miles, and west to Binghamton.

	Feet.
Bulkey's ranch, southeast corner of yard, west side of road; iron post stamped "34 B".....	34.123
Hance Timm's house, 400 feet southeast of, west side of road; iron post stamped "31 B".....	31.334
Jud King's ranch house, 0.5 mile west of, southeast corner of sec. 36, T. 7 N., R. 2 E., southeast corner of field; iron post stamped "21 B".....	20.708
T. 6 N., R. 2 E., near northeast corner of sec. 24, southeast corner of pasture fence; iron post stamped "8 B".....	7.409
T. 6 N., R. 2 E., 1 mile east by 0.25 mile north of Peter's house, southeast corner of field; iron post stamped "17 B".....	17.121

Jud King's ranch house east 2 miles (double spur line).

Jud King's ranch house, 2 miles east of, on north and south fence line, 50 feet east of levee, 150 feet southeast of dead tree on levee; iron post stamped "9 B".....	8.777

Bench mark at forks of Sutter and Steamboat sloughs.

Forks of Sutter and Steamboat sloughs, 0.7 mile north of, 0.25 mile northwest of H. M. Donaldson's ranch house, 300 feet west of Sutter Slough, in northwest corner of Orchard lot; iron post stamped "6 1906 B. N."...	5.916

Courtland southeast to Walnut Grove.

	Feet.
Grand Island, at head of Steamboat Slough, 0.5 mile north of bridge, at Kercheval House; zero of gage (below sea level)	−4.398
Grand Island Bridge, 3 miles east of, 100 feet southeast of schoolhouse, 0.25 mile northwest of pump house, at southeast corner of yard, west side of road; iron post stamped "−2 B. N. 1906" (below sea level)	−2.498

Courtland north, east, and southeast to Pierson District creamery, thence east to Franklin road.

Courtland, 1.2 miles north of, at east edge of levee, 15 feet south of school, in 24-inch oak tree; nail with aluminum tag stamped "17 41"	16.274
Franklin, 4.3 miles southwest by 5 miles west of, on south edge of second-class road, 600 feet southeast of creamery, in pyramid on root of 30-inch oak tree; nail with aluminum tag stamped "6 39"	5.54

BOULDIN, ISLETON, JERSEY, AND RIO VISTA 7½′ QUADRANGLES.

Tolands Landing south across Sherman Island to north bank of San Joaquin River, thence west to Antioch.

Tolands Landing, 3.9 miles south of, at south end of road crossing Sherman Island southward from Tolands Landing, at turn 0.5 mile south of pump house, 100 feet north of San Joaquin River, south of road, 0.25 mile east of house; iron post stamped "−1 1906 B. N." (below sea level)	−1.477

Bench mark at northeast corner of sec. 9, T. 4 N., R. 2 E.

T. 4 N., R. 2 E., corner of secs. 11, 12, 13, and 14, east side of road; iron post stamped "19 B"	18.900

Rio Vista north by Steamboat Slough and Sutter Slough to fork of Sutter and Steamboat sloughs.

Rio Vista, 3.7 miles north of, 0.8 mile south of Westgate's place, 250 feet west of river, 200 feet west of house on north side of road; iron post stamped "−1 B. N. 1906" (below sea level)	−1.130
Walkers Landing, 0.7 mile north of, west side of road, 150 feet west of Steamboat Slough, 250 feet northwest of J. Hollenbeck's house; iron post stamped "4 1906 B. N."	3.600

Walnut Grove south along east side of Tyler Island and west to Rio Vista.

Tyler Island, east side of road across island, 200 feet west of Mokelumne River, on ranch "J" of Bauman property, 0.25 mile south of pump house; iron post stamped "−1 N 1906" (below sea level)	−1.088
Camp C, 140 feet east of house, 100 feet north of Mokelumne River, 100 feet northwest of barn; iron post stamped "0 1906 B. N." (below sea level)	−0.282
Tyler Island ferry landing, 150 feet west of, north side of road, 50 feet west of saloon; iron post stamped "3 1906 B. N."	3.040

Point 5.1 miles southwest of Bracks Landing via Brack's pump house and Staten Island to Brannan's ranch "J."

Tyler Island, east of road, 200 feet west of Mokelumne River, on ranch "J" of Brannan's property, 0.25 mile south of pump house; iron post stamped "−1 1906" (below sea level)	−1.088

Hagansville southwest along North Fork of Mokelumne River to Golden State cannery, thence south and west to Andrus Island pump house, thence north to Isleton.

	Feet.
Hagansville, 250 feet east of Staten Island pump house, on bridge across canal; bolt head painted "U. S. —4 B. M. 36" (below sea level).....	—3.70
Staten Island pump house, 1.8 miles south of, 20 feet south of house, camp 8, at corner of garden; iron post stamped "—1 B 1908 20" (below sea level).	—1.274
Golden State cannery, 100 feet south of, in cottonwood tree; aluminum tag stamped "4–47" (U. S. Corps of Engineers[1] bench mark 26).....	3.91
Golden State cannery, 1 mile south of, at southeast corner of China House 100 feet west of Mokelumne River; iron post stamped "—2 B 1908 21" (below sea level).....	—1.840
Golden State cannery, 1.7 miles southwest of, at angle in canal, 1 mile west of pumping plant; aluminum tag stamped "—8 48" in post painted "U. S. —8 B. M." (below sea level).....	—8.58
Andrus Island, at Jackson Dam, where Isleton road leaves levee and where Jackson Slough joined main slough before it was drained off, 50 feet west of house, 10 feet west of road; iron post stamped "—1 B 1908 22" (below sea level).....	—1.229
Isleton, 1.8 miles south of, where road to Golden State cannery leaves Jackson Slough, 50 feet north of barn, at road angle; iron post stamped "B–1908 —1 23" (below sea level).....	—0.962

Jackson and Lodi 30′ quadrangles.

AMADOR, SACRAMENTO, AND SAN JOAQUIN COUNTIES.

The elevations in the following list are based on the results of precise leveling along the Southern Pacific Railroad from Benicia across the Galt and Woodbridge quadrangles.

The leveling was done in 1907 by B. A. Jenkins, except for a portion of that in the Jackson and Lodi quadrangles done by L. F. Biggs, the latter employing yard rod and prism level, and the former the ordinary Y level.

The work was done in cooperation with the State.

JACKSON 30′ QUADRANGLE.

Carbondale northeast 4 miles, thence northwest to point 2 miles east of Michigan Bar.

	Feet.
Michigan Bar, 3.6 miles east of, north side of road, 15 feet south of fence; iron post stamped "BB 1907 5 255".....	254.849

LODI 30′ QUADRANGLE.

Florin east 3.5 miles.

Florin, 3.5 miles east of, at intersection of roads; iron post stamped "B 32 1907 63".....	63.477

Elk Grove east and northeast along Grant Line road.

Elk Grove, 50 feet west of station; iron post stamped "B 49 1907".....	49.289
Sheldon, at road corner, 50 feet south of Sheldon saloon; iron post stamped "B 1907 73 31".....	73.523

Galt northeast along road 5.4 miles to point 1.7 miles west of Conley.

Conley, 1.7 miles west of, at intersection of roads; iron post stamped "B 1907 62 22".....	61.881

[1] Locally known as U. S. Engineer Department.

Point south of Arno west via Bruceville schoolhouse to crossing of Stockton road and Western Pacific Railway, thence north via Franklin to point 2 miles north of Union schoolhouse and east to Florin.

	Feet.
Bruceville, 20 feet west of schoolhouse, at edge of steps over fence; iron post stamped "B 1907 21 No. 34"	21.167
Franklin, corner of Masonic Hall; aluminum tablet stamped "B 1907 18 35"	18.470
Franklin, 6.7 miles north of, 20 feet north of schoolhouse, in angle of fence; iron post stamped "B 1907 15 36"	15.340

Stockton road crossing on Western Pacific Railway west 3 miles to point 4.3 miles south by 3 miles west of Franklin.

Franklin, 4.3 miles south by 3 miles west of, at southeast corner of bridge across slough; iron post stamped "B 1907 5 37"	4.814

Point 2 miles east of Michigan Bar west along road via Liveoak and Slough House to Grant Line, thence along Grant Line road to point 4 miles northeast of Sheldon.

Michigan Bar, northwest corner of schoolhouse; iron post stamped "BB 1907 6 333"	333.368
Bridge House, 1.4 miles north of, west side of road, 75 feet east of house on summit of rise, at fence corner; iron post stamped "BB 1907 7 154"	154.383

Road intersection 1.7 miles west of Conley north to Slough House.

Slough House, 13.2 miles southwest of, where first road from W. & R.'s colony intersects road; iron post stamped "B 1907 73 27"	73.169
Slough House, 6.1 miles southwest of, in front of ranch house, west side of road; iron post stamped "B 1907 123 28"	123.471
Slough House, 0.8 mile southeast of, in top of south pier of McCracken's bridge; bronze tablet stamped "B 1907 113 29"	113.477

Point near Conley northeast along road to Carbondale.

Conley, 200 feet northeast of station, railroad crossing; top of rail	74.8
Clay, northwest corner of schoolhouse; iron post stamped "BB 1907 105 23"	105.291
Clay, 11 miles northeast of, 200 feet south of Alabama House, at junction of road to Clay, at fence corner; iron post stamped "BB 1907 237"	236.695
Carbondale, in front of station; top of rail	214.0

Liveoak south via Wilbur to Alabama House.

Alabama House, 3.5 miles northwest of, 250 feet west of junction of road, 2 feet west of gatepost; iron post stamped "BB 1907 2 180"	180.109

Point near Wilbur west along road to point 2.5 miles north of Clay.

Alabama House, 6.9 miles west of, 1.4 miles west of Weiss ranch house, junction of road, south side of road, at fence line; iron post stamped "BB 3 1907 141"	140.826
Clay, 3.8 miles northeast of, west side of road, 10 feet south of gate to ranch house, 25 feet west of gate to Mound ranch, at junction of road from Slough House to Clay; iron post stamped "BB 1907 4 113"	112.150
Clay, 2.5 miles north of, where lane from house intersects road; iron post stamped "B 1907 33 103"	103.260

New Grant gate south to point 1.7 miles south of Dry Creek schoolhouse.

Swifts ranch, 400 feet west of ranch house, 10 feet north of road; iron post stamped "B 1907 153 25"	153.218

Bench mark at Tree East triangulation station (by double spur line in 1908).

	Feet.
Slough House, 1 mile southwest of Tree East triangulation station, on land owned by Archie Mull, on Jackson road from Sacramento, near Cosumnes post office, at foot of tree, on west side of road, about 16 inches above ground; iron post	189.819

Lodi east along wagon road to Lockeford, thence north to Dry Creek.

Lodi, 1.2 miles south of, east of railroad at crossing, north of road, at angle of fence; iron post stamped "45"	45.286
Lodi, 3.6 miles east of, where road from south joins Lodi-Lockeford road, angle of fence; iron post stamped "B 1907 72"	71.523
Lockeford, 5.8 miles north of, southwest corner of Elliott schoolhouse grounds; iron post stamped "B 1907 105 15"	105.089

Elliott west along road to cemetery entrance.

Galt, 4.6 miles east of, at intersection of roads; iron post stamped "B 1907 64 16"	63.619

Lockeford east along wagon road to Clements, thence north to point 1.7 miles south of Dry Creek schoolhouse.

Clements, 4.4 miles north of, 20 feet west of road in front of deserted house; iron post stamped "B 1907 214 26"	213.752

Lockeford south along wagon road to Farmington road.

Lockeford, 4 miles south of, where Lodi-San Andreas road crosses Lockeford-Stockton road, 40 feet southeast of, at fence corner; iron post stamped "B 1907 80 9"	79.459
Lockeford, 8 miles south of, angle of fence at intersection of roads; iron post stamped "B 1907 72 10"	71.583
Farmington, near junction with Farmington road; iron post stamped "67".	66.551

Clements south along wagon road to point near Peters.

Clements, 8 miles southeast of, at section corner on north side of road; iron post stamped "B 1907 194 13"	193.802
Bellota, northeast corner of post office; iron post stamped "B 1907 130 14"..	130.232
Peters, near southeast corner of junction of Peters-Linden road; iron post stamped "102"	101.825

Galt west along road via New Hope to Walnut Grove.

Galt, 3.5 miles west of, north side of road, 200 feet east of intersection of fence from north; iron post stamped "B 1907 29 17"	28.467
New Hope, Don Ray & Co. store, southwest corner of cement porch; aluminum tablet stamped "B 1907 13 18"	12.954
New Hope, Don Ray & Co. store, south door of; center of metal doorsill (county bench mark)	13.36

Lodi west along road via Woodbridge to Brack's Landing.

Lodi, northwest corner of opera house; aluminum tablet stamped "B 1907 50.21"	50.504
Woodbridge, northwest corner of Masonic Hall; aluminum tablet stamped "B 1907 45 19"	45.805
Woodbridge, 3 miles west of, intersection of roads; iron post stamped "B 1907 29 20"	29.049

Spur from Brack's Landing west 8 miles to point near pumping plant (stopped by overflow).

	Feet.
Brack's Landing, southeast corner of warehouse; iron post stamped "B 1907 6 41"	6.108

Brack's Landing southeast to Kettleman's ranch, thence east to Southern Pacific Railroad milepost 99.

Brack's Landing, 4.7 miles south of, on Terminus road, north side of road, 400 feet west of levee; iron post stamped "B 1907 38" (erroneously stamped 4)	1.003
Brack's Landing, 9.6 miles southeast of, 500 feet south of Kettleman's ranch house, in fence corner; iron post stamped "1907 B 9 39"	8.722

Intersection of Eightmile House and Lower Sacramento roads south to Fivemile House, thence east to Southern Pacific Railroad and north along railroad to milepost 97.

Fivemile House, 1,000 feet north of, west edge of Lower Sacramento road where lane from west intersects; iron post stamped "B 1907 13 40"	13.063
Lodi, 7.2 miles south of, 15 feet north of milepost 97; iron post stamped "B 1907 28"	28.111

Galt southeast and east to road intersection 1 mile east of entrance to cemetery.

Galt, 30 feet west of track, on line with north end of station; iron post stamped "B 1901 46"	45.576

Byron and Tracy 15′ quadrangles; Holt, Lathrop, Stockton, and Union Island 7½′ quadrangles.

ALAMEDA, CONTRA COSTA, SAN JOAQUIN, AND STANISLAUS COUNTIES.

The elevations in the following list are based on the precise line from Benicia by C. H. Semper.

Most of the leveling was done by L. F. Biggs in 1910, although a part of that in the Byron quadrangle was done in 1907 by B. A. Jenkins. The State cooperated in the work.

HOLT, LATHROP, STOCKTON, AND UNION ISLAND 7½′ QUADRANGLES.

Banta west and north to Grant Line bridge, thence southwest to point 0.8 mile south of pump house.

	Feet.
Banta, 1 mile west of, north side of road, in base of telephone pole 42/9; spike with aluminum tag stamped "31"	31.33
Banta, 1.5 miles west of, at T road south, in base of telephone pole 41/29; spike with aluminum tag stamped "33"	33.04
Banta, 3 miles west of, at T road south to Tracy, in base of telephone pole 40/12; spike with aluminum tag stamped "27"	27.32
Banta, 3.5 miles west of, at T road north; in base of telephone pole 39/31; spike with aluminum tag stamped "27"	26.91
Tracy, 2 miles north of, 600 feet north of Bagley's ranch house, east of road at fence corner; iron post stamped "9, 1910, 1"	9.471
T. 1 S., R. 5 E., corner of secs. 5, 9, 4, and 8, in base of post; spike with aluminum tag stamped "5"	5.11
Tracy, 3.5 miles north of, 1 mile south of Naylee schoolhouse, where road turns north, in root of poplar tree; copper nail with aluminum tag stamped "7"	6.89

	Feet.
Tracy, 4.5 miles north of, 50 feet north of Naylee schoolhouse, 200 feet south of Old River steel bridge, west side of road; iron post stamped "11, 1910, 2"	11.449
Grant Line steel bridge, on southeast corner of abutment; chisel point painted "18"	18.03
Grant Line steel bridge; 22.5 foot mark on gage	14.41
Grant Line steel bridge, 2.5 miles west of, 175 feet south of levee, 150 feet south of pump house, on fence line; iron post stamped "2, 1910, 3"	1.724
Grant Line bridge north and east to Stockton.	
Grant Line bridge, 2.5 miles north of, south side of road, where road crosses levee; iron post stamped "2, 1910, 10"	1.489
Grant Line bridge, 2 miles north by 1 mile east of, north side of road; spike in base of corner fence post; aluminum tag stamped "3"	2.92
Bridge over Middle River, 200 feet east of, at T road north; iron post stamped "6, 1910, 11"	5.603
Middle River, surface of water under bridge November 2, 1910	0.14
Middle River bridge, 2.3 miles east of, 0.6 mile south of Fairchild schoolhouse, at T road south; spike in base of telephone pole, marked "6"	5.78
Fairchild schoolhouse, 1.2 miles north of, 2.5 miles southwest of San Joaquin bridge, opposite road house; iron post stamped "2, 1910"	1.460
San Joaquin River, surface of water under bridge November 2, 1910	0.1
San Joaquin Bridge, 60 feet east of, north side of road, at fence line; iron post stamped "7, 1910"	7.156
Stockton, 2 miles south of, at junction of French Camp and Roberts Island roads, west levee of canal; spike in base of telephone pole; aluminum tag stamped "16"	15.37
Stockton, south edge of town, junction of South Center and East Jackson streets; spike in base of telephone pole; aluminum tag stamped "13".	12.46
Stockton, west door of north entrance of San Joaquin County courthouse, in angle of wall; bronze tablet stamped "18 B"	17.953
Holt along road north to Black Slough Landing (unchecked spur line).	
Holt, 300 feet west of station, south edge of right of way, east edge of road leading south; iron post stamped "10, 1910, 15"	9.935
Black Slough Landing, south of, southwest corner of bridge over canal; top of bolt painted "−3" (below sea level)	−1.40
Black Slough Landing, 90 feet northeast of Gorden's house, on edge of levee, San Joaquin River; brass-capped pipe marked "U. S. E. D. No. 206"	11.327
Middle River west and north along road to Holt.	
Kingston schoolhouse, 300 feet northeast of, at angle of road to north, west side of road at fence line; iron post stamped "7, 1910, 14"	6.422
Stockton, 5.8 miles west of, 200 feet east of milepost 1127, on levee at fence corner; iron post stamped "9"	8.805
Point 1.5 miles north of Stockton west to U. S. Corps of Engineers[1] bench mark 0.8 miles east of Shipyard Island (checked spur line).	
Stockton, 1.5 miles north of, 8 feet north of milepost 94, east side of track, near fence line; iron post stamped "20 B" (United States Corps of Engineers value 23.388)	20.075

[1] Locally known as U. S. Engineer Department.

	Feet.
Stockton, 2 miles north of, southwest abutment of bridge over Calaveras River; top of bolt head marked "27"	26.81
Western Pacific crossing; top of rail	28.5
Stockton, 2 miles north of, on lower Sacramento road, 6 feet south of southeast abutment of bridge over Calaveras River; copper bolt in cap with aluminum tag stamped "19"	19.382
Lower Sacramento road bridge, 1.2 miles west of, north levee of canal, 200 feet southwest of fence corner, in stump; copper nail with aluminum tag stamped "20"	20.290
Lower Sacramento road bridge, 2.5 miles west of, north edge of levee, at northeast corner of house at Smith's place; iron post stamped "3"	3.372
Smith's house, 1 mile west of, spike in base of power pole 5/15; aluminum tag stamped "—1" (below sea level)	—1.146
Elmwood Farm No. 2, 800 feet east of barn; spike in base of power pole 6/7; aluminum tag stamped "2"	1.683
Shipyard Island, 0.5 mile east of, east bank of San Joaquin River, at pumping station, in top of a pile; copper bolt with aluminum tag stamped "8"	8.307
Shipyard Island, 0.2 mile east of, right bank of San Joaquin River, 40 feet back of levee midway between house and barn; iron post marked "U. S. E. D. No. 205" (United States Corps of Engineers value 4.770)	0.996
Point 2.5 miles north of Grant Line bridge to Camp No. 1 Landing.	
Victoria Island, 0.5 mile east of, 40 feet south of Middle River levee, 5 feet south of red tank house; iron post stamped "4, 1910, 17"	4.302
Camp No. 1 Landing, on top of levee, 50 feet north of barn in top of snubbing post; copper nail, with aluminum tag stamped "16"	16.40
Point 2.3 miles east of Middle River southeast to French Camp.	
Brant Bridge, south end abutment of; aluminum tablet stamped "21, 1910, 30"	20.639
Brant Bridge, 1.2 miles east of, at T road south, in telephone pole; spike with aluminum tag stamped "11"	10.92
French Camp, 1.3 miles south of, east side of road at T road west, in base of locust tree; spike with aluminum tag stamped "18"	17.27
French Camp, 2.1 miles south of, on east side of railroad at road crossing, 200 feet south of milepost 85; iron post stamped "19 B 1901"	18.971
TRACY 15′ QUADRANGLE.	
Point 1 mile west of Ellis south and west to San Joaquin Bridge, thence northwest to Banta.	
Ellis, 2 miles south of, at Western Pacific Railway crossing; spike in base of telephone pole; aluminum tag stamped "168"	168.22
T. 3 S., R. 5 E., corner of secs. 4, 5, 8, and 9, 2.5 miles south by 1 mile west of Tracy, at Western Pacific Railway crossing; iron post stamped "148, 1910, 5"	148.371
Tracy, 3.5 miles south by 1 mile west of, 2 miles south of Jefferson schoolhouse, at railroad crossing; spike in base of telephone pole; aluminum tag stamped "199"	198.99
Tracy, 4.5 miles south by 1 mile east of, at crossroads; iron post stamped "140, 1910, 6" (T. 3 S., R. 5 E., corner of secs. 14, 15, 22, and 23)	139.628
San Joaquin Bridge, 4 miles west of, at Southern Pacific crossing; spike in base of telephone pole; aluminum tag stamped "83"	83.14
San Joaquin Bridge, 0.5 mile west of, at T road; iron post stamped "45, 1910, 7"	47.155

	Feet.
San Joaquin Bridge, 1 mile northwest of, east side of road, at second-class road to east; spike in base of telephone pole; aluminum tag stamped "41".	43.19
San Joaquin Bridge, 2 miles northwest of, opposite T road west, in base of telephone pole, scribed and painted "33;" spike	35.32
San Joaquin Bridge, 4 miles northwest of, 5 miles southeast of Banta, east side of road, opposite power pole 19/2; iron post stamped "37, 1910, 8"	39.227
Banta, 3.7 miles southeast of, at crossroads; spike in base of telephone pole; aluminum tag stamped "31"	33.14
Banta, 2.5 miles southeast of, opposite second-class road west; spike in base of telephone pole; aluminum tag stamped "23"	24.48
Banta, 1.9 miles southeast of, at Western Pacific Railway crossing; spike in base of telephone pole; marked "19"	20.75
Banta, 1 mile southeast of, at T road to east; spike in base of telephone pole; aluminum tag stamped "18"	20.11
Banta, 10 feet north of milepost 75, south side of track; iron post stamped "22.181"	22.119

Point 1 mile west of Ellis east to Tracy.

Ellis, 1 mile west of, 4 feet north of milepost 69; iron post stamped "102.656 B"	102.594
Tracy, 2 miles west of, at road crossing; spike in base of telephone pole; aluminum tag stamped "67"	66.93
Tracy, 1 mile west of, spike in base of milepost 71; aluminum tag stamped "65"	64.72
Tracy, 0.4 mile north of station, 4 feet north of milepost 72, on fence line north side of track; iron post stamped "54, 1910, 8"	53.875

Point 3 miles west of Banta south to Tracy.

Banta, 3 miles west of, at T road south to Tracy; spike in base of telephone pole 40/12; aluminum tag stamped "27"	27.26
Tracy, 0.4 mile north of station, 4 feet north of milepost 72, at fence line; iron post stamped "54, 1910, 8"	53.875

BYRON 15′ QUADRANGLE.

Bethany Ferry to Bethany.

Bethany, 100 feet east of station, on edge of right of way; iron post stamped "36, 1910, 4"	36.145

Point 1 mile west of Camp No. 1 Landing to Bixler.

Camp No. 1 Landing, 1 mile west of, south bank of canal, 10 feet south of pumping plant, in top of pile; copper nail with aluminum tag stamped "2".	2.42
Old River Farms Co. Landing No. 5, 800 feet east of, south edge of levee at road leading south, 40 feet east of canal, 50 feet south of pump house; iron post stamped "2, 1910, 18"	1.727
Old River Farms Co. Landing No. 3, 50 feet north of office, in base of telephone pole; spike with aluminum tag stamped "7"	6.77
Coney Island, upper end of, 1,000 feet south of edge of east levee of old river, 150 feet south of warehouse, 5 feet north of old building; iron post stamped "7, 1910, 19"	7.158
Old Ferry, 1 mile north of, west bank of canal, northwest corner of house, in root of willow tree; copper nail with 0 aluminum tag stamped "1"	0.65
Mouth of Italian Slough, north levee, at landing; nail in top of snubbing post; aluminum tag stamped "11"	11.02

	Feet.
Italian Slough, 0.7 mile north of, at junction of road west to Byron, at west edge of levee, near northwest corner of house; iron post stamped "1, 1910, 24"	1.356
Italian Slough, 2 miles north of, west levee of Old River, 10 feet south of house, in root of willow tree; copper nail with aluminum tag stamped "0"	0.59
Mansion House, 1.3 miles south of, west levee of Old River, 20 feet north of old house, in base of willow tree; spike with aluminum tag stamped "1"	1.45
Mansion House, 1,000 feet north of, west levee of Old River, opposite canal between Victoria and Woodward Island, at northeast corner of old house; iron post stamped "3, 1910, 25"	2.952
Mansion House, 1.3 miles west of, south bank of Indian Slough, at pump house, in base of power pole; spike with aluminum tag stamped "2"	1.77
Mansion House, 2.5 miles west of, 2 miles south and 1 mile east of Bixler, 200 feet south of white house, 40 feet west of Indian Slough, at end of lane; iron post stamped "6, 1910, 26"	6.584
Bixler, 2 miles south of, at crossroads, in base of gum tree; spike with aluminum tag stamped "12"	11.93
Bixler, 1 mile south of, at crossroads, in base of power pole 0/20; spike with aluminum tag stamped "9"	9.61

Bethany north and west to Oakley.

Bethany, 1.5 miles northwest of, at T road west, in base of telephone pole; spike with aluminum tag stamped "43"	42.78
Mountain House school, 0.5 mile north by 1 mile west of, at T road north to Billy Campbell's ranch; iron post stamped "76, 1910, 20"	75.781
Byron, 5.2 miles south of, at power line crossing, in base of power pole 68/12; spike with aluminum tag stamped "81"	81.20
Byron, 3 miles southeast of, at junction of road to south, in base of power pole 1 8; spike with aluminum tag stamped "14"	13.72
Byron, 1.5 miles south of, at junction of road to Byron Hot Springs, east of railroad right of way; iron post stamped "23, 1910, 21"	23.171
Byron, south edge of town, 200 feet south of railroad crossing, in base of power pole 4 12; spike with aluminum tag stamped "25"	25.43
Byron, 2 miles west of, at junction of road to west, on fence line; iron post stamped "165, 1910, 22"	164.891
Byron, 3 miles west by 2 miles north of, 1,500 feet east of Marsh Creek bridge, 700 feet east of junction of Martinez and Brentwood roads, 150 feet north of road at point of hill, in bowlder outcrop; aluminum tablet stamped "209, 1910, 23"	208.856
Brentwood, 0.5 mile southwest of, 800 feet south of storehouse west of road, in base of 60-inch oak tree; spike with aluminum tag stamped "160"	159.98
Stone House, 1 mile north of, west bank of Marsh Creek, 100 feet south of windmill, in base of sycamore tree; spike with aluminum tag stamped "111"	111.34
Stone House, 2 miles north of, 60 feet west of Marsh Creek, 2 feet west of house; iron post stamped "27 1910 100"	100.723
Brentwood, 1 mile west of, west abutment of steel bridge over Marsh Creek; aluminum tablet stamped "81, 1910, 28"	81.119
Brentwood, 1.5 miles northwest of, in base of milepost 81, Southern Pacific Railroad; spike with aluminum tag stamped "82"	82.60
Brentwood, 2 miles northwest of, at road crossing, east of right of way; iron post stamped "95, 1910, 29"	95.249

	Feet.
Ohara, 0.5 mile southeast of, at junction of road to north, in base of telephone pole; spike with aluminum tag stamped "84"	84.22
Oakley, 1 mile west of, at crossroads, in base of power pole 18/14; spike with aluminum tag stamped "28"	29.50
Oakley, west end of station, 30 feet south of track; iron post stamped "19"	19.180

Middle River northeast to Empire Cut (unchecked spur line).

Middle River, 1 mile north of, in base of power pole 1/3; spike with aluminum tag stamped "−2" (below sea level)	−1.947
Middle River, 1.8 miles northeast of, west side of bridge over slough, in floor; copper nail marked "1"	0.868
Middle River, 3 miles northeast of, at Empire Cut Landing No. 12, in base of power pole 3/8; spike marked "−0" (below sea level)	−0.060
Middle River, 3 miles northeast of, at Empire Cut Landing No. 12, in base of power pole 3/9; spike marked "0"	0.255

Tule west along Atchison, Topeka & Santa Fe Railway to point 3 miles east of Antioch.

Tule, in front of signboard; top of rail	11.3
Middle River, in front of station; top of rail	16.1
Middle River, at southeast corner of cannery; iron post stamped "B 1907 3, 3"	3.292
Orwood, in front of station; top of rail	13.8
Werner, in front of signboard; top of rail	12.0
Bixler, in front of signboard; top of rail	15.0
Bixler, 200 feet southeast of signboard, at road corner, 20 feet east of section corner; iron post stamped "B 1907 15 4"	14.322
Knightsen, west end of station, 40 feet south of track; iron post stamped "B 1907 27 5"	26.460
Oakley, in front of station; top of rail	18.4

Dunnigan 15′ quadrangle; Knights Landing, Lincoln, Marcuse, Nicolaus, Pleasant Grove, Rocklin, Roseville, Sheridan, and Vernon 7½′ quadrangles.

COLUSA, PLACER, SUTTER, AND YOLO COUNTIES.

The following elevations are based upon results of precise leveling along the Southern Pacific Railroad published in Bulletin 342.

The leveling in the Dunnigan quadrangle was done in 1904 by C. H. Semper and in 1908 by W. H. Monahan; in the Marcuse, Nicolaus, Knights Landing, and Vernon quadrangles in 1904 by Semper, in 1905 by G. C. Douglas, and in 1908 by L. F. Biggs and Monahan; in the Lincoln, Pleasant Grove, Roseville, and Sheridan quadrangles in 1908 by Biggs and Monahan; and in the Rocklin quadrangle in 1908 by Biggs. The work was done in cooperation with the State.

DUNNIGAN 15′ QUADRANGLE.

Hershey southeast along Southern Pacific Railroad to Yolo.

	Feet.
Hershey, 50 feet west of track, at road crossing, 50 feet north of Colusa-Yolo County line; iron post stamped "137 B"	137.126
Dunnigan, 60 feet north of station, at edge of park fence; iron post stamped "67 B"	67.018

	Feet.
Dunnigan, 3.2 miles south of, 50 feet east of milepost 101, 60 feet east of track, at road crossing; iron post stamped "45 B"	44.955
Zamora (Blacks Station post office), 0.6 mile north of, 0.2 mile south of milepost 98, east of track, at corner of fence on right of way at public road crossing, sec. 17, T. 11 N., R. 1 E.; iron post stamped "46 B"	45.841
Ronda station, east of track at corner of right of way fence at road crossing near milepost 94.7; iron post stamped "54 B"	54.193

College City southeast and south to point near Dunnigan.

John's school, 1.1 miles north of, fence at southeast angle of crossroads; iron post stamped "43 B"	43.017
Spanish ranch house, 1.6 miles north of, south side of county line, at entrance to ranch; iron post stamped "47 B"	47.024
Vombreyman's ranch, at fence line, northeast angle of road to north; iron post stamped "36 B"	35.702

Sam Hines ranch via Howell Point to Rough and Ready Landing.

Wilkins Slough school, at west end of fence, road in front of school; iron post stamped "32 B"	32.140
Wilkins Slough school, 2.3 miles south of, at road to J. M. Miller's ranch house; iron post stamped "34 B"	34.163
Howells Point, entrance to landing, Yolo-Colusa County line; iron post stamped "37 B"	37.383
Howells Point, 1.8 miles south of, gate leading to Ern Miller's ranch house; iron post stamped "31 B"	31.071
Rough and Ready Landing, at junction of canal and river, south side of canal, 40 feet west of large oil tank; iron post stamped "40 B"	40.633

Knights Landing west 4.9 miles, thence north to Rough and Ready Landing.

Blacks Station post office, 4.3 miles east of, at crossroads to Yolo and Grimes Landing, northeast corner angle of roads; iron post stamped "41 B"	**41.177**

Zamora (Blacks Station post office) east 4.3 miles.

Blacks Station post office, 2.5 miles east of, at corner of gate to barnyard of F. Schliemann's ranch house; iron post stamped "49 B"	**49.093**

Dunnigan southwest and south along county road to point near Brimley ranch.

Brimley ranch, 1 mile north of, summit between Dunnigan and Fairview schoolhouse, east side of road; iron post stamped "333 B"	**333.203**

Point 6.3 miles west by 1 mile north of Marcuse via Kirkville to point near Sutter School.

Kirkville, 2.5 miles south of, 3 miles north of Sutter schoolhouse, at angle in road at east side, 500 feet south of deserted building, where road turns east from river 0.5 mile in angle of road and north again 2 miles south of Perry Hyatt's place; iron post stamped "Prim. Trav. Sta. No. 160 CAL 1908 33"	**32.860**
Sutter schoolhouse, in county road, 2 feet from fence near northeast corner of schoolhouse yard; iron post stamped "Prim. Trav. Sta. No. 161 CAL 1908 36"	**35.744**

Kirkville north by road to point 3.6 miles north of Salem School.

Kirkville, 2 miles north of, east of road which passes through small grove of oak trees, 0.5 mile south of Mr. Correll's place, at base of small oak tree; iron post stamped "Prim. Trav. Sta. No. 200 1908 28"	**28.259**

	Feet.
Salem school, 1.4 miles north of, on east side of road, under large black-oak tree, 2,000 feet north of H. Poffenberger's place; iron post stamped "Prim. Trav. Sta. No. 210 CAL 1908 42"	42.411

KNIGHTS LANDING, MARCUSE, NICOLAUS, AND VERNON 7½' QUADRANGLES.

Rough and Ready Landing southeast along river road to Knights Landing station.

Derby Camp, 1.3 miles east of, north edge of river levee, opposite Chinese camp; iron post stamped "39 B"	39.432
Knights Landing, bridge over Sacramento River, top of south abutment, south end of west wing wall; aluminum tablet stamped "41 B"	41.553
Knights Landing station, 30 feet east of track, at corner of road, opposite north side of station; iron post stamped "32 B"	31.825

Knights Landing south along river road to Grays Bend.

Knights Landing, 4 miles southeast of, west side of road at foot of levee, south line of Mr. Roseberry's place; iron post stamped "30 B"	30.132

Grays Bend east down river road to Elkhorn weir.

Knights Landing, 10.6 miles southeast of, 0.25 mile north of Doyle's house, 40 feet west of junction of river road and lane, north side of road; iron post stamped "29 B"	28.958

Point near Riego northwest to Ryan, thence north to Pleasant Grove station.

Sankey, 2 miles southwest of Northern Electric Railroad station; Ryan triangulation station, 20 feet northwest of windmill; iron post stamped "34 B 1908 B. E. 1"	34.564
Pleasant Grove, Northern Electric Railroad station, east of track, west of road, at fence line, 10 feet south of power pole; iron post stamped "32 B 1908 B. F. 1"	31.975

Pleasant Grove station north 7 miles, thence west via Nicolaus to Chandler.

Alamos, in front of station; top of rail	35.1
Striplin, 100 feet east of station, east of right of way, at fence corner; iron post stamped "33 B 1908 B. M. I"	33.359
Nicolaus, in front of station; top of rail	41.9
Nicolaus, southwest corner of school yard; iron post stamped "33 B 1908 B. N. I"	32.864
Nicolaus, 1.4 miles west of, in center of road, in base of 48-inch oak tree; spike with aluminum tag stamped "31 B. M. 146"	30.72
Chandler, in front of station; top of rail	36.6
Chandler, 0.1 mile south of, opposite milepost 106, 6 feet east of track; iron post stamped "36 B 1902"	36.227

Forks of road 3.3 miles northwest of Riego west to Verona School, thence north to Nicolaus.

Verona, 2 miles east of, Barney Mound triangulation station; iron post stamped "35 B 1908 B. R. I"	34.899
Verona, 1 mile east of, southwest of road, 150 feet south of warehouse, in base of 30-inch oak tree; spike with aluminum tag stamped "33 B. M. 153"	33.55
Verona, 25 feet north of northeast corner of schoolhouse, at fence line; iron post stamped "28 B 1908 B. P. I"	28.592
McNamara ranch house, 1.2 miles southwest of, 75 feet north of Mahon's dairy ranch, at section line, east of levee; iron post stamped "38 B 1908 B. O. I."	38.316

	Feet.
McNamara ranch house, 100 feet west of, south of road, at fence; iron post stamped "40.2" (U. S. E. D. bench mark No. 37)	36.877
Nicolaus, 3.2 miles southwest of, south of river road, in base of 36-inch cottonwood tree; spike with aluminum tag stamped "27 B. M. 149"	27.10

Point 4 miles north of Chandler west to point 3.5 miles south of Bear River Bridge, thence north to point 10 miles south of Marysville.

Wheatland, 4 miles south by 4.8 miles west of, north of road, 300 feet north of intersection of roads; iron post stamped "59.9 B. M. 27"	56.187
Bear River Bridge, 1.1 miles south of, 250 feet west of Western Pacific Railway at bend of road, at fence line; iron post stamped "47.5 B. M. 21"	43.861
Bear River Bridge, 150 feet north of, east of road, at fence line; iron post stamped "46 B 1908 B. B. 2"	46.448

Point 4 miles west by 2 miles north of Marcuse to Marcuse.

Marcuse, 2.6 miles west by 1 mile north of, at southwest corner of crossroads; iron post stamped "31 1908"	31.208
Marcuse, 0.4 mile north of, on west side of railroad at fence line, 5 feet north of milepost 109; iron post stamped "33 B 1902"	32.878

Point 3.4 miles west by 1 mile north of Marcuse west toward Kirkville.

Marcuse, 5.8 miles west by 1 mile north of, west of road, 300 feet west of levee, driven in ground; iron peg marked "25"	24.94

Point 4.5 miles northeast of Kirkville.

Kirkville, 4.5 miles northeast of, south of road in tule swamp, standing out prominently; iron post stamped "22 CAL 1908"	22.115

Point near Sutter School to Knights Landing.

Knights Landing, 2.6 miles north of, on east side of river road under black-walnut tree, 1,200 feet north of white house with yellow-green roof; iron post stamped "Prim. Trav. Sta. No. 142 CAL 1908 35"	34.748
Knights Landing, at railroad station, 30 feet east of track at corner of highway and on line of north side of station; iron post stamped "32 B 1902"	31.825

Point on Southern Pacific Railroad 3 miles south of Chandler west to old railroad grade, thence northeast to forks of road 2.6 miles west of Marcuse.

Chandler, 3 miles south of, on west side of railroad, 10 feet from track, opposite milepost 103; iron post stamped "38 B 1902"	38.006
Marcuse, 2.6 miles west by 6.2 miles southwest of, at north end of abandoned trestle of Southern Pacific Railroad and at south end near center of old grade, near end of line of willow trees; iron post stamped "22 CAL 1908"	21.468
Marcuse, 2.6 miles west by 5 miles southwest of, in base of tree on west side of old grade railroad bed; spike with aluminum tag stamped "22"	22.13
Marcuse, 2.6 miles west by 1.9 miles southwest of, west of old railroad bed; iron peg driven flush with ground, marked "26"	26.17
Marcuse, 2.6 miles west by 1 mile southwest of, west of old railroad bed; iron peg driven flush with ground, marked "27"	26.91

Point 3.4 miles west by 1 mile north of Marcuse southwest 2.25 miles (doublespur line).

Yuba City, 16.6 miles southwest of, on levee about 3 miles west of Marcuse, near old cabin, iron post stamped "Prim. Trav. Sta. No. 305 38 CAL 1908"	38.402

LINCOLN, PLEASANT GROVE, ROSEVILLE, AND SHERIDAN 7½′ QUADRANGLES.

Wheatland southeast along Southern Pacific Railroad to Roseville.

	Feet.
Sheridan, 300 feet south of station, northeast corner of brick warehouse; iron post stamped "114 B 1908 B. E."	114.007
Sheridan, 2.7 miles south of, east of track, 10 feet east of milepost 123; iron post stamped "110 P. B. M. F."	110.016
Lincoln, 2 miles north of, east of track, 15 feet east of milepost 120, at fence line; iron post stamped "141 P. B. M. G."	141.458
Lincoln, 30 feet east of track, north end of station; iron post stamped "163 H"	163.197
Lincoln, Burdge Hotel, northeast corner of concrete sidewalk; aluminum tablet stamped "167 I"	167.687
Lincoln, 3.9 miles south of, east of track, in fence line, 20 feet northeast of milepost 114; iron post stamped "124 K"	124.188
Roseville, 3.5 miles north of, east of track, in fence line, 20 feet northeast of milepost 111; iron post stamped "131 L"	131.589
Roseville, in northeast corner of school yard; iron post stamped "159 B. B. M."	159.935

Roseville west along road to point near Riego.

Roseville, southeast corner of brick church, 4 feet above ground; aluminum tablet stamped "159 N"	159.661
Roseville, 2.6 miles west of, north of road, at Rosecrest, 50 feet west of live-oak tree (forked) 24 inches in diameter; iron post stamped "153 O"	153.819
Roseville, 5.9 miles west of, north of road, on summit between two drains; at fence line; iron post stamped "103 P"	103.272
Roseville, 8.6 miles west of, west of road, 20 feet east of road junction, 3 feet south of fence; iron post stamped "63 Q"	63.609
Riego, in front of station; top of east rail	43.8
Riego, 500 feet southeast of Johnson ranch house, at bend of road, south of road, 10 feet west of telephone pole; iron post stamped "40 B 1908 B. C. 1"	39.954
Johnson ranch house, 1 mile northwest of, east of second-class road, in base of locust tree; spike with aluminum tag stamped "32 112"	32.344

Roseville northeast along Southern Pacific Railroad toward Rocklin.

Roseville, 2.1 miles east of, north of track, in base of milepost 110; spike with aluminum tag stamped "201 96"	201.49

Pleasant Grove along road east 4 miles, thence south to crossroads 2.6 miles east of Riego.

Pleasant Grove, at road junction, 75 feet northwest of hotel, 15 feet east of windmill, at fence corner; iron post stamped "47 B. 1908 B. G. 1"	47.516
Pleasant Grove, 2.7 miles east of, in northeast angle of second-class road junction, 5 feet east of fence corner; iron post stamped "75 B 1908 B. H. 1"	74.792
Falconer ranch, 1.9 miles south of, west of road, at section line; iron post stamped "64 B 1908 B. I. I."	63.617

Forks of road 7 miles west of Roseville north and east, thence north and west to forks of road 2.7 miles east of Pleasant Grove.

Roseville, 5 miles west of; Kaseborg triangulation station at west end of cabin; iron post stamped "106 B 1908 B. J. 1"	106.153
Pleasant Grove, 250 feet west of schoolhouse, west side of road, at fence corner; iron post stamped "106 B 1908 B. K. 1"	105.662

Pleasant Grove north along road 9.25 miles, east 3.7 miles, and north to Wheatland.

	Feet.
Pleasant Grove, 3.5 miles north of, west of road at intersection of roads, 150 feet south of house, in southeast corner of lot; iron post stamped "50 B 1908 B. X. 1"	50.478
Pleasant Grove, 7.1 miles northeast of, south of road, at intersection of roads at point where line turns west, 25 feet north of gate; iron post stamped "53 B 1908 B. Y. 1"	54.877
Wheatland, 4 miles south by 3.7 miles west of, south of road, at intersection of roads where power line turns south, 25 feet east of power poles 34–20; iron post stamped "61 B 1908 B. Z. 1"	61.805
Wheatland, 4 miles south of, south of road, at intersection of roads, 25 feet west of gate, where power line turns west, 50 feet south of power pole 31 6; iron post stamped "82 B 1908 B. A. 2"	82.000
Wheatland, 0.5 mile south of, east of road, at fence line; iron post stamped "83.3 B. M. 48" (United States Corps of Army Engineers[1] B. M. 48)	79.600

Forks of roads 9.2 miles north of Pleasant Grove west along road.

Wheatland, 4 miles south by 4.7 miles west of, south of road, at intersection of road from north, at section line, in base of fence post; spike with aluminum tag stamped "55 B. M. 182"	55.65

Forks of roads 5.9 miles north of Pleasant Grove east to Lincoln.

Lincoln, 4.4 miles west of, south of road at road crossing, at fence corner; iron post stamped "104 B 1908 B. L. 1"	104.242

Pleasant Grove northeast and north to crossroads 4.4 miles west of Lincoln.

Pleasant Grove, 6.6 miles northeast of, at northeast corner of intersection of roads; iron post stamped "104 B 1908 B. S. 1"	103.829

Lincoln north along road 6.6 miles, thence west to Sheridan.

Lincoln, 3.4 miles north of, at northwest corner of road intersection; iron post stamped "174 CAL 1908"	173.900
Lincoln, 5.1 miles north of, at northeast corner of T road east, on top of stone; chiseled square marked "173"	190.95
Lincoln, 6.6 miles north of, 4.5 miles east of Sheridan, at northwest corner of road intersection; iron post stamped "258 CAL 1908"	258.593
Sheridan, 2 miles east of, at southeast corner of bridge over small stream, 175 feet west of T road north, in post; spike with aluminum tag stamped "117"	117.65

Point near Wheatland west 2 miles to Sheridan.

Wheatland, 3.1 miles east of, north of road, 800 feet east of intersection of roads, in fence line; iron post stamped "78.2 B. M. 49" (United States Corps of Army Engineers bench mark)	74.536

Point 3.1 miles east of Roseville.

Roseville, 3.1 miles east of, south of right of way, 10 feet north of fence corner, 200 feet south of milepost 111; iron post stamped "219 B 1908 B.W."	218.625

[1] Locally known as U. S. Engineer Department.

ROCKLIN 7½′ QUADRANGLE.

At Rocklin.

	Feet.
Rocklin, 60 feet northeast of station, in foundation at southwest corner of roundhouse; aluminum tablet stamped "244 B 1908 B. X."	244.429

Browns Valley, Gillsizer Slough, Grimes, Marysville Butte, Meridian, Ostrom, Smartsville, Spencerville, Sutter, Tisdale Weir, Wheatland, and Yuba City 7½′ quadrangles, and Smartsville special quadrangle.

COLUSA, NEVADA, SUTTER, AND YUBA COUNTIES.

The elevations in the following list are based on the results of precise leveling along the Southern Pacific Railroad published in Bulletin 342.

The leveling in the Grimes, Marysville Butte, Meridian, and Tisdale Weir quadrangles was done in 1904 by C. H. Semper and E. M. Fry, in 1908 by W. H. Monahan, and in 1909 by W. H. Barringer; in the Gillsizer Slough, Ostrom, Sutter, and Yuba City quadrangles in 1908 by L. F. Biggs and Monahan, and in 1909 by Biggs; in the Browns Valley, Smartsville, Spencerville, and Wheatland quadrangles in 1908 by Biggs and Monahan; and in the Smartsville special quadrangle in 1908 by Biggs. The work was done in cooperation with the State.

GILLSIZER SLOUGH, OSTROM, SUTTER, AND YUBA CITY 7½′ QUADRANGLES.

Marysville north by Southern Pacific Railroad and east along road to Sevenmile House.

	Feet.
Marysville, 225 feet west of track, at southeast corner of railroad park; iron post stamped "61–B 1902"	61.202
Marysville, 2.5 miles north of, south of railroad, at fence line, 5 feet north of milepost 145; iron post stamped "65–1"	65.400
Marysville, 5.7 miles north of, 50 feet south of railroad, at fence corner, 800 feet north of milepost 148; iron post stamped "73–2"	71.896
Sevenmile House, 3 miles west of, at northeast corner of bridge over Nigger Jack Slough; top of painted bolt with aluminum tag stamped "75 5"	74.43
Sevenmile House, 2.3 miles west of, northeast corner of granite milepost; notch marked "80 6"	79.45
Sevenmile House, 1 mile west of, east of road, 50 feet north of junction, 5 feet west of power pole; iron post stamped "90 3"	89.724

Point 1.2 miles southwest of Brophy School west to Marysville.

Brophy school, 1.2 miles southwest of, south of road, north of fence, opposite house on small rise; iron post stamped "84 21"	83.815
Marysville, 3.7 miles east of, north of road, 5 feet north of fence line, 1,000 feet northwest of house on mound; iron post stamped on rim "74.8" (United States Corps of Army Engineers[1] B. M. 71, their elevation 74.8 feet)	70.236
Marysville, 3.2 miles east of, north of road, at fence line, opposite house; iron post stamped on rim "U. S. E. D. 75" (United States Corps of Army Engineers B. M. 73, their elevation 75 feet)	70.323

[1] Locally known as U. S. Engineer Department.

Marysville southeast toward Earle.

	Feet.
Marysville, 2.5 miles southeast of, at northwest corner of crossroads; iron post stamped "68 CAL 1908"	68.490
Marysville, 4.3 miles southeast of, on tiling at northwest corner of T road; chiseled square; aluminum tag stamped "65"	65.38

Marysville along Southern Pacific Railroad to Ostrom.

Marysville, 2.7 miles south of, 50 feet east of milepost 139, at fence, east of track; iron post stamped "61 B 1908 A. B."	61.239
Marysville, 5.7 miles south of, east of track, 40 feet east of milepost 136, at fence; iron post stamped "56 B 1908 B. B."	56.535

Point near Plumas School west to Marysville road, thence south.

Bear River Bridge, 3.7 miles north of, east of road, at intersection of road, 250 feet east of old house; iron post stamped "49 B 1908 B.C.2"	48.722
Bear River Bridge, 2.4 miles north of, southeast corner of bridge over small creek; top of painted bolthead and aluminum tag stamped "46 186"	45.93

Marysville south along road via Howard station to forks of road 2.5 miles north of Bear River Bridge.

Howard, 1 mile south of station, 60 feet east of Northern Electric Railroad right of way, at bend of road, in fence corner; iron post stamped "53 B 1908 B.D.2"	53.529

Yuba City west, south, west, and south to point 4 miles west by 2 miles north of Marcuse.

Marysville, 0.9 mile south of station, west of railroad, at fence line, 5 feet north of milepost 121; iron post stamped "58 B 1902"	57.712
Yuba City, 3.4 miles southwest of, in southeast corner of Lincoln schoolyard; iron post stamped "52"	52.003
Grant School, at northwest corner of yard, at crossroads; iron post stamped "299 1908 41 Prim. Trav. Sta."	41.296
Grant School, 3.6 miles south of, in southwest corner of bridge over pond; top of bolt with aluminum tag stamped "36"	36.02
Grant School, 4.8 miles south of, west of road, 150 feet north of Christopherson's ranch house; iron post stamped "35 CAL 1908"	35.381

Point 2 miles south by 0.5 mile east of Sutter City east along road to fork of roads 2.2 miles southwest of Yuba City.

Sutter City, 2 miles south by 0.5 mile east of, in east corner of junction of T roads; iron post stamped "44 CAL 1908"	43.656
Sutter City, 2 miles south by 2.2 miles east of, in culvert over road; spike with aluminum tag stamped "46"	46.14
Sutter City, 2 miles south by 3.5 miles east of, in southwest corner of schoolhouse yard; iron post stamped "50 CAL 1908"	50.171
Sutter City, 2 miles south by 4.5 miles east of, north of road, in front of small cottage, in base of tree; spike with aluminum tag stamped "51"	51.39

Grant School west and north toward Sutter City.

Grant School, 2.5 miles west of, west of road at fork of road from north; iron post stamped "Prim. Trav. Sta. 36 CAL 321 1908"	36.087

Point 3.6 miles northeast of Marysville along road west and north to point 2.6 miles north of Wooddrift schoolhouse.

Wooddrift schoolhouse, 0.4 mile west of, 60 feet northeast of junction of Marysville road, at fence corner; iron post stamped "69 B 1909 B.A."	68.902

	Feet.
Wooddrift schoolhouse, 0.4 mile west by 1 mile north of, center of road, in base of 36-inch oak tree; spike with aluminum tag stamped "72 B.M. 3".	71.81
Wooddrift schoolhouse, 2 miles north of, 300 feet south of section line, west side of road, in base of 40-inch live oak tree; spike with aluminum tag stamped "75 B.M. 4"	74.78

Point 7.1 miles northeast of Marysville northeast 10 miles, thence west to Honcut (portion of line).

Nigger Jack Slough, 3.2 miles north of, southwest corner of intersection of east-west road; iron post stamped "95 B 1909 B.T."	94.609

Yuba City west along county road to Sutter City.

Yuba City, 3.8 miles west of, north edge of road, at section line west edge of ditch, 30 feet north of bridge; iron post stamped "53 B 1909 B.K."	52.831

Sutter City north, east, and north along county road 7 miles.

Sutter City, 1 mile north by 1 mile east of at section line, west end of large gate to second-class road, in base of gate post; spike with aluminum tag stamped "56 B.M. 40"	55.94
Sutter City, 1 mile north by 2 miles east of, north side of road, southeast corner of eucalyptus grove at intersection of road to north; iron post stamped "53 B 1909 B.L."	53.494
Sutter City, 2 miles east by 2 miles north of, west edge of road, in base of 40-inch oak tree; spike with aluminum tag stamped "57 B.M.41"	57.27
Sutter City, 2 miles west by 3.1 miles north of, 0.3 mile south of Union schoolhouse, west edge of road, 200 feet north of dry creek, in base of 20-inch oak tree; spike with aluminum tag stamped "62 B.M.42"	62.70
Union schoolhouse, northeast corner of school yard; iron post stamped "66 B 1909 B.M."	65.855

GRIMES, MARYSVILLE BUTTE, MERIDIAN, AND TISDALE WEIR 7½′ QUADRANGLES.

Colusa southeast to Sycamore.

Sycamore, at east margin of highway, opposite saloon, between locust trees; iron post stamped "48 B"	48.129

Forks of road 2.7 miles south of Sycamore south and west to Arbuckle.

Grimes Landing, northwest corner of Main and Second streets; iron post stamped "47 B"	47.089
Sam Hines' ranch, in northwest angle of roads; iron post stamped "32 B"	32.108
Sam Hines' ranch, 2.6 miles west of, 145 feet west of levee, south of road; iron post stamped "26 B"	25.932
College City, 1.5 miles north and east of, 1,100 feet west of bridge over slough, at southeast angle of road to south; iron post stamped "36 B"	35.824

Point 3.6 miles north of Salem School northwest via Eddys Ferry to Meridian.

Eddys Ferry, 4.5 miles southeast of, at west corner where road turns at an angle of 90 degrees to right; iron post stamped "Prim. Trav. Sta. No. 215 CAL 1908 41"	41.089
Eddys Ferry, 1 mile north of, on top of levee, in dredge cut, 500 feet west of road and 300 feet north of residence of Gerdine's dairy, first house on left side of road from Eddys Ferry; iron post stamped "Prim. Trav. Sta. No. 222 CAL 1908 47"	46.554
Eddys Ferry, 3.4 miles northwest of, in front of large red brick house, in base of fig tree; spike with aluminum tag stamped "49"	48.93

	Feet.
eridian, 2.2 miles south of, at base of levee, west side of road, 150 feet south of C. D. Crookan's house; iron post stamped "Prim. Trav. Sta. No. 227 CAL 1908 51"	50.717
eridian, at northeast corner of G. W. Wood's yard, intersection of county road to Colusa and ferry road; iron post stamped "Prim. Trav. Sta. No. 260 CAL 1908 51"	51.291

Meridian east to vicinity of Sutter City.

eridian, 3.5 miles east of, in base of levee on Butte Slough, north of road, in angle opposite first house from Slough schoolhouse; iron post stamped "Prim. Trav. Sta. No. 265 CAL 1908 45"	45.064
utter City, on southeast corner of Colusa and Acacia streets, at the corner of Clement's barnyard; iron post stamped "Prim. Trav. Sta. No. 277 CAL 1908 67"	67.194

oint 2 miles southwest of Duckhunter clubhouse southwest to river road 3.7 miles southeast of Eddys Ferry.

rant School, 2.5 miles west of, thence 3.5 miles southwest of, south of road, in tule swamp, 300 feet northeast of small lake; iron post stamped "30 1908 CAL"	29.654

oint 3.5 miles east of Meridian northwest and east along highway to Pennington.

West Butte, 3.1 miles southeast of, lower side of road, on bowlder; chisel point painted "48 U.S.B.M. 61"	47.75
West Butte, 0.5 mile east by 1.5 miles south of, in front of Tarke's ranch (white house), east side of road, in bowlder; aluminum tablet stamped "54 B 1909 B.V."	53.691
West Butte, 2.2 miles north of, north side of road, 800 feet east of shacks on hillside above road, 15 feet north of center of roadway, in bowlder; aluminum tablet stamped "67 B 1909 B.W."	67.297
Noyesburg, 1.4 miles north by 0.3 mile east of schoolhouse, east side of road, 100 feet south of white house, on top of small knoll, 5 feet west of east fence line along road, in large bowlder; aluminum tablet stamped "71 B 1909 B.X."	71.190

Colusa south along highway to Meridian.

Colusa, Colusa County courthouse, 2 miles southeast of, east side of road, in base of 4-inch sycamore tree; copper brad with aluminum tag stamped "59 B. M. 52"	58.82
Colusa, 5 miles southeast of, east side of levee road, 0.25 mile southeast of farmhouse, 2 miles northwest of Kent, 2 feet north of telephone pole painted "U. S. B. M.;" iron post stamped "58 B 1909 B.T."	58.336
Meridian, 4 miles northeast of, 0.3 mile south of Kent, east side of road, in front of brown house and 100 feet north of entrance to yard; iron post stamped "54 B 1909 B. N."	54.671
Meridian, 3.1 miles north of, 1.2 miles south of Kent, east side of road, in front of white house, in base of large fig tree; spike with aluminum tag stamped "54 B. M. 57"	54.53

Union schoolhouse south along highway to Colusa (portion of line).

Colusa, north wall of Colusa County courthouse, 15 feet west of main entrance; aluminum tablet stamped "60 B 1904"	60.375

BROWNS VALLEY, SMARTSVILLE, SPENCERVILLE, AND WHEATLAND 7½′ QUADRANGLES AND GREATER PART OF SMARTSVILLE SPECIAL QUADRANGLE.

Sevenmile House east by road to Parks Bar Bridge crossing river, thence southwest by road to point 1.2 miles southwest of Brophy school.

	Feet.
Sevenmile House, 1.6 miles east of, 50 feet east of junction of road, 10 feet north of telephone pole, north of road; iron post stamped "143 4"...	143.088
Sevenmile House, 4.5 miles east of, 500 feet east of road junction to Browns Valley, north side of road, 150 feet west of dwelling, in bowlder; aluminum tablet stamped "191 5".....	190.921
Sevenmile House, 6.3 miles east of, west of road, 50 feet east of junction of road, in base of 36-inch pine tree; spike with aluminum tag stamped "247 12".....	246.46
Barrier No. 1, 0.3 mile northwest of, 18 feet south of section post 14, 150 feet north of Yuba River; iron post stamped "204.7" (U. S. E. D. B. M. No. 26).....	200.111
Barrier, on top of north abutment; chisel point painted "220 14".....	220.14
Barrier, 0.7 mile southeast of, 400 feet southeast of draw, 400 feet from bar gate, north bank of river, 600 feet south of cabin on knoll, 10 feet north of river, 5 feet south of wire fence, on rock; chisel point painted "214"..	213.69
Parks Bar Bridge, 1 mile southwest of, south of road, 20 feet south of bridge over small creek, in base of 24-inch white oak tree; spike scribed and painted "266 B. M. 42".....	265.49
Brady ranch, 0.3 mile southwest of, north of road, at summit of rise, 15 feet north of fence, in country bowlder; aluminum tablet stamped "349 18"..	348.486
Heigson's ranch, 0.1 mile southwest of, north of road, 15 feet south of fence, on summit of rise, in country bowlder; aluminum tablet stamped "227 19"	226.831
Lane ranch, 200 feet north of house, north of road, southeast corner of corral; iron post stamped "97 20".....	96.824

Ostrom southeast along Southern Pacific Railroad to Wheatland.

Ostrom, 2.3 miles south of, east of track, 5 feet north of milepost 133; iron post stamped "71 B 1908 B. C.".....	71.242
Wheatland, north end of railroad station, 5 feet east of telephone pole; iron post stamped "86 B 1908 B. D.".....	86.104
Wheatland, water tower, northwest corner of granite foundation; chisel point; iron foot plate stamped "91 B. M. 61".....	90.71
Wheatland, in front of north end of station; top of rail.....	85.8

Wheatland north to fork of road 2.1 miles west of Brady ranch.

Wheatland, 5 miles northeast of, at northeast corner of T roads, near corner of fence; iron post stamped "101 CAL 1908".....	101.052
Earle, 300 feet southwest of schoolhouse, at southwest corner of crossroads; iron post stamped "116 CAL 1908".....	115.894
Earle, 2 miles north of, at west side of road, 450 feet north of lane leading to house on east side of road, on rock; chiseled square marked "123"....	123.45
Earle, 3.5 miles north of, in southeast corner of lane fence leading to house on right; iron post stamped "189".....	189.471

Earle west by road to point 4.3 miles southeast of Marysville.

Earle, 4 miles west of, 390 feet west of gate leading to the Boardman ranch house; iron post stamped "74 CAL 1908".....	73.762

Parks Bar Bridge east via Smartsville to Mooney Flat and bridge over Deer Creek.

	Feet.
Parks Bar Bridge, north side of road, 30 feet north of bridge, 10 feet east of oak tree, in bowlder; aluminum tablet stamped "252"	251.387
Parks Bar Bridge, on northeast abutment; top of bedplate	244.05
Parks Bar Bridge, on southwest abutment; top of bedplate	247.58
Smartsville, 1.4 miles north of, at northeast corner of bridge over Yuba Creek, top of truss; painted bolt with aluminum tag stamped "345 16"	344.21
Smartsville, 250 feet east of schoolhouse, south of road, 10 feet south of junction of road, on large bowlder painted "619 18;" chisel point	618.97
Smartsville, southeast corner of porch foundation to Reardon's hotel; aluminum tablet stamped "684 9"	683.321
Smartsville, 0.6 mile south of, east of road at road junction, on bowlder painted "792 19;" chisel point	791.20
Smartsville, 1.2 miles north of, east of road, 100 feet east of crossroads, 15 feet north of ditch on summit of hill, in bowlder; aluminum tablet stamped "996 10"	955.552

Point 4.5 miles west of Bridgeport south and west along south bank of Yuba River to Parks Bar.

Mouth of South Fork of Yuba River, 4.4 miles southwest of, south bank of river, at James Bar, 25 feet west of cable over river, on rock painted "373 33;" chisel point	372.69
Mouth of South Fork of Yuba River, 5.7 miles southwest of, opposite draw, south side of river, 1,000 feet west of barn on opposite bank of river, 50 feet west of claim stake, on rock painted "346 34;" chisel point	345.97
Mouth of South Fork of Yuba River, 6.5 miles southwest of, southwest point of mouth of draw, 500 feet west of draw, on opposite side of river, steep rocky point, 50 feet above river bed, in large bowlder; aluminum tablet stamped "354 16"	353.865
Mouth of Deer Creek, 200 feet east of, on bench, east bank of creek, south bank of Yuba River, in top of knot in 30-inch two-forked oak tree scribed and painted "329 35;" spike	328.01
Mouth of Deer Creek, 0.7 mile southwest of, south side of river, upper end of gorge at bend of river opposite steep bluff underneath overhanging rock, on bowlder painted "287 37;" chisel point	286.47
Narrows, 15 feet east of north anchorage of cable, on rock point; aluminum tablet stamped "318 17"	317.733
Parks Bar Bridge, 2.6 miles east of, at end of long sand bar, 15 feet south of 36-inch live-oak tree, overhanging bank, on bedrock painted "259 39;" chisel point	269.13
Parks Bar Bridge, 0.5 mile east of, north bank of river, on point between two draws, 20 feet north of water's edge, on rock painted "227 41;" chisel point	237.18

SMARTSVILLE SPECIAL QUADRANGLE (PART NOT INCLUDED IN THE WHEATLAND 15′ QUADRANGLE).

Point near Mooney Flat northeast to Bridgeport, thence west 4.5 miles.

Mooney Flat, 1.3 miles northeast of schoolhouse, north of road, 15 feet south of 36-inch bull pine tree, on bowlder painted "797 23;" chisel point	795.03
Mooney Flat, 2 miles northeast of schoolhouse, south of road, opposite round hill, in large bowlder; aluminum tablet stamped "1011 11"	1,010.840
Mooney Flat, 3 miles northeast of, north of road, 50 feet west of end of lane, near top of ridge, on bowlder painted "1168 24;" chisel point	1,166.78

	Feet.
Mooney Flat, 4.1 miles northeast of, east of road, on summit of ridge, bend of road, on steep bluff, on large bowlder painted "1223 26;" chisel point.	1,222.72
Anthony House, 1 mile northeast of, north of road, 20 feet east of ditch, on summit of rise, on bowlder painted "1259 29;" chisel point	1,259.20
Anthony House, 1.6 miles northeast of, south of road, at ditch crossing, 500 feet east of cemetery, in bowlder; aluminum tablet stamped "1334 12"	1,333.936
Rapps ranch, 0.7 mile northeast of, north of road, on bowlder painted "1000 30;" chisel point	1,000.305

Bangor 15′ quadrangle; Biggs, Butte City, Butte Creek, Cherokee, Clear Creek, Dayton, Dry Creek, Durham, French Crossing, Gridley, Honcut, Keefers, Nelson, Newhard, Nord, Oroville, Palermo, and Pennington 7½′ quadrangles.

BUTTE, COLUSA, GLENN, SUTTER, AND YUBA COUNTIES.

The elevations in the following list are based upon the results of precise leveling along the Southern Pacific Railroad published in Bulletin 342.

The leveling was done in 1909 in the Biggs, Butte Creek, Butte City, Cherokee, Clear Creek, Dry Creek, Dayton, Durham, French Crossing, Gridley, Honcut, Pennington, Palermo, Newhard, Nelson, and Oroville quadrangles by L. F. Biggs and W. H. Barringer; in the Bangor, Keefers, and Nord quadrangles by L. F. Biggs.

The work was done in cooperation with the State.

BANGOR 15′ QUADRANGLE.

Point 7.1 miles northeast of Marysville, northeast 10 miles, thence west to Honcut (portion of line).

	Feet.
Honcut, 4 miles southeast of, south end of large gate, at second-class road to Honcut, 150 feet north of house, west edge of road; iron post stamped "119 B 1909 B. U."	118.719
Honcut Creek, 1 mile southwest of, 10 feet east of road, 1,000 feet south of Bryden ranch house, on 3 by 2 foot bowlder; chisel point painted "158 B. M. 69"	157.65
Honcut Creek, 0.7 mile south of, 0.5 mile north of Bryden ranch, at junction of road to east, west side of road, in base of 24-inch oak tree; spike with aluminum tag stamped "208 B. M. 72"	207.96
Honcut, 4.5 miles northeast of, Honcut Creek bridge, northeast pier; aluminum tablet stamped "168 B 1908 B. W."	168.248
Honcut, 4.3 miles northeast of, 0.2 mile west of Honcut Creek, at intersection of north-south road, in base of stump; spike with aluminum tag stamped "194 B. M. 73"	193.99

Bryden ranch east 2.8 miles (spur line).

Bryden ranch, 1.3 miles southeast of, 400 feet east of junction of road, 10 feet west of road, in base of 24-inch oak tree; spike with aluminum tag stamped "324 B. M. 70"	324.20
Buckeye schoolhouse, 2 miles north of, south side of road, on hill above creek, in base of 36-inch oak tree; spike with aluminum tag stamped "292 B. M. 71"	291.80
Buckeye schoolhouse, 2.6 miles northeast of, 2 miles north of Chinn Butte triangulation station, on first section line east of butte, 20 feet north of road at section line; iron post stamped "334 B 1909 B. V."	334.190

BUTTE CITY, BUTTE CREEK, FRENCH CROSSING, AND PENNINGTON 7½′ QUADRANGLES.

Biggs west to Princeton.

	Feet.
Biggs, 0.7 mile north of, west edge of railroad right of way, where wagon road turns west, in base of telephone pole; spike with aluminum tag stamped "91 B. M. 83''.	90.320
Biggs, 1.8 miles west of, southeast corner of bridge over drain, in concrete abutment; aluminum tablet stamped "86 B 1909 B.''.	85.967
Biggs, 2.6 miles west of, northwest corner of bridge over drain in top of concrete abutment; spike with aluminum tag stamped "84 B. M. 85''..	84.57
Biggs, 3.2 miles west of, northwest corner of bridge over Spring Valley Mining Co.'s canal, in top of cord; bolt head with aluminum tag stamped "90 B. M. 86''.	89.84
Biggs, 3.6 miles west of, 100 feet west of junction of road to north, south side of road, in base of telephone pole; spike with aluminum tag stamped "79 B. M. 87''.	79.44
Biggs, 4.7 miles west of, south side of road, at junction of road to north, in base of telephone pole; spike with aluminum tag stamped "76 B. M. 88''	76.12
Biggs, 5.4 miles west of, at Landlow schoolhouse, northeast corner of school yard; iron post stamped "77 B 1909 B. A.-1''.	77.488
Landlow schoolhouse, 1 mile west of, south side of road, 100 feet west of old barn, in base of cottonwood tree; spike with aluminum tag stamped "72 B. M. 94''.	72.14
East fork of Butte Creek, 0.4 mile west of, south side of road, at section line northeast corner of field; iron post stamped "70 B 1909 B. C. 1''.	70.106
West fork of Butte Creek, northwest corner of bridge over, in floor; spike with aluminum tag stamped "72 B. M. 98''.	72.24
Union schoolhouse, 2 miles east of, at intersection of north-south road northeast corner of field, in base of fence post; spike with aluminum tag stamped "71 B. M. 100''.	70.88
Union schoolhouse, 2 miles east of, northeast corner of intersection of north-south road; iron post stamped "72 B 1909 B. D. 1''.	71.900
Union schoolhouse, 1 mile east of, north edge of road, on section line, in base of fence post; spike with aluminum tag stamped "71 B. M. 101''..	71.65
Union schoolhouse, 200 feet north of, 3 miles south of Butte City, 150 feet north of Marvin Chapel, northeast corner of churchyard, at intersection of north-south road; iron post stamped "74 B 1909 B. E. 1''.	74.161
Union schoolhouse, 1.5 miles west of, 0.2 mile south of, at Flannigan's ranch, in yard, in base of 48-inch oak tree; copper brad with aluminum tag stamped "78 B. M. 36''.	78.69
Princeton, at ferry crossing, on east river bank, in base of 36-inch oak tree; spike with aluminum tag stamped "72 B. M. 37''.	72.60
Sacramento River, at Prince Ferry; surface of water, May 25, 1909.	65.6

Point 7.4 miles west of Biggs north along highway to Wilson (portion of line).

Biggs, 7.4 miles west by 1.5 miles north of, 2 miles west by 1.5 miles north of Landlow schoolhouse, 20 feet south of northwest corner of fence, 0.25 mile west of white barn, in base of fence post; spike with aluminum tag stamped "77 B. M. 2''.	76.37
Landlow schoolhouse, 2 miles west by 2.5 miles north of, at intersection of county and second-class road, 150 feet east of ranch house, 10 feet west of telephone pole; iron post stamped "81 B 1909 B. A.''.	80.645

	Feet.
Landlow schoolhouse, 2 miles west by 5 miles north of, southeast corner of field, west of road, at fence corner; iron post stamped "92 B 1909 B. B.".	92.056
Landlow schoolhouse, 2 miles west by 6 miles north of, west side of road, in base of fence post near gate; spike with aluminum tag stamped "91 B. M. 5''.	90.74
Point 2 miles west of Landlow schoolhouse west and south to Union schoolhouse.	
Landlow schoolhouse, 2.3 miles west by 2.5 miles north of, 6.7 miles east of Butte City, in floor of Butte Creek bridge; copper brad with aluminum tag stamped "84 B. M. 27''.	84.03
Butte City, 5 miles east of, on north side of road, near section fence line, in base of telephone pole; spike with aluminum tag stamped "77 B. M. 28''.	77.056
Butte City, 3.5 miles east of, county road bridge over small slough, white house on west bank of slough, in floor at east end of bridge; copper brad with aluminum tag stamped "84 B. M. 29''.	83.62
Butte City, 3.3 miles east of, at intersection of north-south and east-west roads, 1,500 feet east of ranch house in clump of trees and long barn on north side of road, northeast corner of roads; iron post stamped "80 B 1909 B. M.''.	79.983
Butte City, 2.3 miles east of, at intersection of private road to south, south side of road, in base of fence post at gate; spike with aluminum tag stamped "81 B. M. 30''.	80.72
Butte City, 1.2 miles east of, at intersection of north-south and east-west roads, in fence post which is evidently also a bench mark for some other survey, southeast corner of road crossing; 20-penny nail with aluminum tag stamped "81 B. M. 31''.	80.26
Butte City, at Nelson road entrance, 1,000 feet east of Dr. Gatliff's drug store, in base of telephone pole at street corner; spike with aluminum tag stamped "85 B. M. 32''	84.58
Butte City schoolhouse, opposite, in corner of fences, at south end of blind street running north-south; iron post stamped "87 B 1909 B. N.''.	86.200
Butte City, 1.2 miles east by 1 mile south of, east side of road, at section fence line, in base of 12 inch by 12 inch post; spike with aluminum tag stamped "77 B.M. 33''.	76.31
Butte City, 1.2 miles east by 2.2 miles south of, in center of county road, in base of large blazed oak tree; copper brad with aluminum tag stamped "78 B. M. 34''.	77.65
Union schoolhouse, 300 feet north of, 3 miles south by 1.2 miles east of Butte City, 150 feet north of Marvin Chapel, northeast corner of churchyard, at intersection of north-south road; iron post stamped "74 B 1909 B. E.-1''.	74.163
Parrott district schoolhouse south along highway to point 3.3 miles east of Butte City (portion of line).	
Butte City, 3 miles east by 2.4 miles north of, east edge of road, at second class road to west, in base of telephone pole; spike with aluminum tag stamped "90 B. M. 75''.	87.84
Butte City, 3 miles east of, 1.4 miles north of, east edge of road, in base of second telephone pole south of bridge over drain; spike with aluminum tag stamped "85 B. M. 76''.	82.87
Butte City, 3 miles east by 0.2 mile north of, southwest corner of bridge over slough, in floor; copper nail with aluminum tag stamped "85 B. M. 77''.	82.94

Union schoolhouse south along highway to Colusa (portion of line).

	Feet.
Union schoolhouse, 1 mile south of, in front of Boehmer's ranch, in base of telephone pole; spike with aluminum tag stamped "71 B. M. 38"	71.41
Union schoolhouse, 1.5 miles south of, at Afton post office, on west side of road, in base of telephone pole; spike with aluminum tag stamped "70 B. M. 39"	70.13
Union schoolhouse, 1.5 miles south by 1 mile west of, 25 feet east of east bank of Drum Kelley Slough, south side of road, in base of 48-inch oak tree; spike with aluminum tag stamped "75 B. M. 40"	74.75
Union schoolhouse, 1.5 miles south by 2 miles west of, 2 miles west of Afton post office, at intersection of road running south to Colusa, 0.5 mile north of Warfield's ranch, north side of road; iron post stamped "77 B 1909 B. O."	76.797
Afton, 2 miles west by 1 mile south of post office, crossing of road over Sacramento River levee, 0.5 mile south of Warfield's ranch, east side of road, in base of telephone pole; spike with aluminum tag stamped "83 B. M. 41"	83.60
Afton, 2 miles west by 2 miles south of post office, 1 mile north of Harmony schoolhouse, east of road at turn, 50 feet east of levee, in base of telephone pole; spike with aluminum tag stamped "76 B. M. 42"	75.84
Harmony schoolhouse, 12 miles northeast of Colusa, in front of schoolyard and 5 feet north of gate; iron post stamped "76 B 1909 B. P."	76.153
Harmony schoolhouse, 0.3 mile south of, at turn in road, 1,000 feet west of ranch house, in base of telephone pole; spike with aluminum tag stamped "75 B. M. 43"	74.76
Harmony schoolhouse, 1.3 miles south of, 0.2 mile west of, entrance to Moulton ranch, east side of road, in base of 12 by 12 inch gatepost; spike with aluminum tag stamped "70 B. M. 4"	70.39
Harmony schoolhouse, 2 miles south of, 2 miles north of Butte Creek schoolhouse, 20 feet north of entrance to ranch house, 2 feet north of telephone pole; iron post stamped "71 B 1909 B. Q.;" pole painted "U. S. B. M.".	70.820
Butte Creek schoolhouse, 1 mile north of, 300 feet east of ranch house on west side of road, in base of gatepost of section line fence on east side of road; spike with aluminum tag stamped "70 B. M. 45"	70.01
Butte Creek schoolhouse, in southwest corner of yard, in base of tree; spike with aluminum tag stamped "68 B. M. 46"	67.98
Butte Creek schoolhouse, 1 mile south of, near gate on east side of road, 500 feet north of two large barns, 300 feet north of road crossing over Sacramento River levee; iron post stamped "67 B 1909 B. R."	67.258
Butte Creek schoolhouse, 2 miles south of, 6 miles north of Colusa, 1,500 feet south of jog in road on east side, in base of 24-inch oak tree; spike with aluminum tag stamped "62 B. M. 47"	62.32
Colusa, 5 miles north of, turn in road to south, 600 feet south of Farnsworth ranch, in base of fence post at corner; spike with aluminum tag stamped "64 B. M. 48"	64.61
Colusa, 4 miles northeast of, 0.6 mile north of Washington schoolhouse, 20 feet east of oak tree 40 inches in diameter, near gate; iron post stamped "59 B 1909 B. S."	58.910
Colusa, 3.4 miles northeast of, at Washington schoolhouse, in base of tree in road; spike with aluminum tag stamped "62 B. M. 49"	61.69

Gridley west and south to Liveoak (portion of line).

Gridley, 3.8 miles west of, north of road at point where telephone line crosses to south of road, in base of telephone pole; spike with aluminum tag stamped "75 B. M. 18"	74.27

	East.
Gridley, 4.8 miles west of, north of road, at junction of north-south road, in base of telephone pole; spike with aluminum tag stamped "72 B. M. 19"	71.32
Gridley, 5.7 miles west of, 0.5 mile north of Butte schoolhouse, at junction of road to south, north of road, 5 feet west of signpost; iron post stamped "71 B 1909 B. G."	70.543
Butte schoolhouse, yard of, in base of gatepost; spike with aluminum tag stamped "71 B. M. 20"	70.71
Butte schoolhouse, 0.5 mile south of, southwest corner of field at intersection of east-west road, in base of telephone pole; spike with aluminum tag stamped "67 B. M. 21"	66.91
Butte schoolhouse, 1.5 miles south of, east of road at section line, in base of fence post; spike with aluminum tag stamped "71 B. M. 22"	70.73
Butte schoolhouse, 2.5 miles south of, 2.1 miles north of Pennington, west edge of road, at intersection of east-west road, 500 feet west of large barn; iron post stamped "71 B 1909 B. H."	71.192
Pennington, 1.2 miles north of, west side of road, at fence line, in base of fence post; spike with aluminum tag stamped "68 B. M. 23"	67.71
Pennington, 0.2 mile west of, at intersection of east-west road, northwest corner of concrete culvert; bolt head with aluminum tag stamped "79 B. M. 24"	79.05
Pennington, northwest corner of schoolyard, at fence line; iron post stamped "82 B 1909 B. I."	83.577
Pennington, 1.8 miles southeast of, south side of road, at junction of road to east, large gate to lane, in base of gatepost; spike with aluminum tag stamped "76 B. M. 26"	75.01
Pennington, 3 miles east of, 5 miles west of Live Oak, south side of road, at entrance of lane to house, in base of gatepost; spike with aluminum tag stamped "70 B. M. 27"	69.61
Point 3.5 miles east of meridian northwest and east along highway to Pennington (portion of line).	
Noyesburg, 2.5 miles northeast of schoolhouse, 6.7 miles west of Pennington, 200 feet east of turn in road, 150 feet east of sheep dipping corral, in base of fence corner post; spike with aluminum tag stamped "62 B. M. 68"	62.70
Pennington, 5.5 miles west of, opposite private road to north, south side of road at turn, in base of telephone pole; spike with aluminum tag stamped "86 B. M. 69"	86.61
Pennington, 5.1 miles west of, at private road intersection to south, 20 feet north of gate at turn in road to northeast; iron post stamped "84 B 1909 B. Y."	85.110
Pennington, 4 miles west of, at turn in county road, small bridge over drainage ditch, at south side of road, in stringer; copper brad painted "64 B. M. 70"	64.56
Pennington, 3 miles west of, at turn in road to north, 2,000 feet south of large grove of oak trees, on northwest corner of road intersection, in fence corner; iron post stamped "75 B 1909 B. Z."	76.467
Pennington, 1.5 miles west of, at road corners north-south and east-west, in base of 36-inch oak tree; copper brad with aluminum tag stamped "80 B. M. 71"	81.06
Landlow schoolhouse south to point 5.7 miles west of Gridley.	
Biggs, 5.4 miles west of, at Landlow schoolhouse, northeast corner of school yard; iron post stamped "77 B 1909 B. A.-1"	77.488

	Feet.
Landlow schoolhouse, 1.1 miles south of, west side of road, where road turns west, in base of fence post; spike with aluminum tag stamped "73 B. M. 89"	72.76
Landlow schoolhouse, 2.2 miles south of, west side of second-class road, through Balfour Guthrie ranch, 0.5 mile north of Guthrie house, in base of telephone pole; spike with aluminum tag stamped "69 B. M. 90"	69.20
Landlow schoolhouse, 3 miles southeast of, 0.5 mile south of Balfour Guthrie ranch house; west bank of Spring Valley Mining Co. canal, 20 feet north of road; iron post stamped "75 B 1909 B. B.-1"	75.372
Balfour Guthrie ranch, 1 mile south of, 0.5 mile south of Spring Valley Mining Co. canal, on second-class road, west side of road, in base of fence post; spike with aluminum tag stamped "67 B. M. 91"	67.00
Gridley, 7.7 miles west of, at junction of second-class road through Guthrie ranch, in base of telephone pole; spike with aluminum tag stamped "67 B. M. 92"	67.08
Gridley, 6.6 miles west of, north edge of road, in base of telephone pole; spike and aluminum tag stamped "67 B. M. 93"	66.98
Gridley, 5.7 miles west of, 0.5 mile north of Butte schoolhouse, at junction of road to south, north edge of road, 5 feet west of signpost; iron post stamped "71 B 1909 B. G."	70.543

DAYTON, DURHAM, NELSON, AND NEWHARD 7½′ QUADRANGLES.

Durham east along highway to Oroville-Chico road.

Durham, at Southern Pacific Railroad crossing; top of rail	160.7
Durham, 0.8 mile east of, southeast corner of bridge over Butte Creek, in floor; copper nail with aluminum tag stamped "167 B. M. 11"	166.77
Durham, 1.8 miles east of, north edge of road, 300 feet east of bridge over drain, 1 mile east of Butte Creek, in base of 20-inch oak tree; spike with aluminum tag stamped "155 B. M. 12"	155.29
Durham, 2.9 miles east of, south side of bridge over dry creek, in floor; spike painted "161 B. M. 13"	161.37
Durham, 4 miles east of, at junction of Durham-Oroville-Chico roads, 10 feet west of signpost; iron post stamped "181 B 1909 B.3"	181.556

Point 7.4 miles west of Biggs north along highway to Nelson (portion of line).

Landlaw schoolhouse, 2 miles west by 6.8 miles north of, east side of north abutment of concrete culvert over small creek; aluminum tablet stamped "93 B 1909 B. C."	92.171
Landlaw schoolhouse, 2 miles west of by 7.3 miles north, county wagon bridge over Butte Creek, north end, in floor; copper brad with aluminum tag stamped "100 B. M. 6"	99.83
Landlaw schoolhouse, 2 miles west by 8.4 miles north of, 5.3 miles west of Nelson, 1 mile west of county bridge on Oroville road over Butte Creek, at turn in Oroville road and power line; iron post stamped "100 B 1909 B. D."	99.987
Nelson, 4.3 miles west of, county bridge over Butte Creek on Oroville road, in stringer over southwest pier; painted bolt with aluminum tag stamped "111 B. M. 7"	111.01
Nelson, 3.3 miles west of, northeast corner of field, opposite Chinese ranch house, in base of fence post; spike with aluminum tag stamped "105 B. M. 8"	104.40
Nelson, 2.1 miles west of, northwest corner of field, opposite private road to ranch house, south side of Oroville road; iron post stamped "108 B 1909 B. E."	107.847

	Feet.
Nelson, 1.1 miles west of, in front of ranch house on north side of road, in base of telephone pole; spike with aluminum tag stamped "112 B. M. 9".	111.54
Nelson, 700 feet north of station, on east side of railroad, 5 feet north of milepost 173; iron post stamped "120 B 1902"	119.767

Chico west along highway to St. John.

Chico, State normal school, southwest corner of building, front face; aluminum tablet stamped "201 B 1902"	200.776
Chico, west end of town, south side of road, at intersection of river road and road to south, in base of telephone pole; spike with aluminum tag stamped "177 B. M. 20"	177.08
Chico, 0.7 mile west of, where road bends to south, 15 feet south of gate to Morehead ranch, in base of telephone pole; spike with aluminum tag stamped "174 B. M. 21"	174.31
Chico, 1.2 miles west of, south side of road, at intersection of road to south, in base of telephone pole; spike with aluminum tag stamped "166 B. M. 22"	165.78
Chico, 2 miles west of, south edge of road, 800 feet west of water tank, 60 feet east of oak tree; iron post stamped "154 B 1909 B–5"	153.893
Chico, 2.8 miles west of, north edge of road, opposite river road schoolhouse, in base of 40-inch oak tree blazed on south side; copper nail with aluminum tag stamped "143 B. M. 23"	142.67
Chico, 4 miles west of, 1.2 miles west of river road schoolhouse, south side of road, 100 feet west of cross fence line, in base of telephone pole; spike with aluminum tag stamped "131 B. M. 24"	131.04
Chico, 4.4 miles west of, 1.5 miles west of river road schoolhouse, where road bends northwest, north end of gate to second-class road through Phelan ranch, in base of telephone pole; spike with aluminum tag stamped "129 B. M. 25"	129.03
Chico Landing, 0.6 mile south of, northwest corner of bridge over slough, in cap; spike with aluminum tag stamped "136 B. M. 26"	134.42
Chico Landing, east edge of road, 30 feet north of lane to house, opposite boat landing, 3 feet from signpost; iron post stamped "132 B 1909 B. 6".	132.180
Chico Landing, 0.8 mile west of, north edge of Northern Electric Railroad right of way, 150 feet east of end of trestle, in base of 30-inch oak tree; spike with aluminum tag stamped "130 B. M. 27"	129.54
Seco station, Northern Electric Railroad, southwest corner of cattle guard; copper nail with aluminum tag stamped "140 B. M. 28"	138.71
St. John, Northern Electric Railroad station, at road crossing; top of rail..	139.5
St. John, 300 feet south of Stony Creek, 40 feet northeast of intersection of crossroads, in southwest corner of school yard; iron post stamped "143 B"	142.996

Point 4.4 miles west of Chico south to Parrott school district (portion of line).

Chico, 4.4 miles west of, 1.5 miles west of river road schoolhouse where road turns northwest, in base of telephone pole at north end of gate to second-class road through Phelan ranch; spike with aluminum tag stamped "129 B. M. 25"	129.03
Chico Landing, 2 miles southwest of, east edge of road, east end of field gate, in base of 24-inch oak tree; spike with aluminum tag stamped "120 B. M. 29"	119.76
Phelan hog ranch, 5 feet west of field gate, west edge of second-class road, 3.2 miles south of Chico Landing; iron post stamped "123 B 1909 B. 7".	123.408

	Feet.
Phelan hog ranch, 0.7 mile south of, south end of field, east bank of creek, at field gate, in base of 24-inch oak tree; spike with aluminum tag stamped "120 B. M. 30"	119.82
Parrott schoolhouse, 0.6 mile north of, 0.8 mile south of large brick house, east side of road, at fence corner, in base of 24-inch oak tree; spike with aluminum tag stamped "117 B. M. 31"	117.51
Parrott schoolhouse, southwest corner of school yard, at intersection of second-class road; iron post stamped "112 B 1909 B. 8"	112.033
Parrott schoolhouse, 1.3 miles south of, 250 feet northeast of house, on Parrott ranch, 15 feet west of road, in base of 24-inch oak tree; spike with aluminum tag stamped "106 B. M. 71"	106.28
Parrott schoolhouse, 2.4 miles south of, 200 feet south of large gate, west edge of road, in base of 24-inch oak tree; spike with aluminum tag stamped "101 B. M. 72"	100.78
Parrott schoolhouse, 3.6 miles south of, at Parrott triangulation station, 20 feet north of road, 100 feet west of large new barn; iron post stamped "109 B 1909 B. 19"	108.905
Parrott triangulation station, 1.8 miles south of, southwest corner of yard of white house, in base of fence post; spike with aluminum tag stamped "102 B. M. 73"	102.06
Butte City, 3 miles east by 5 miles north of, where road turns east, 15 feet east of fence corner; iron post stamped "102 B 1909 B. 20"	102.286
Butte City, 3 miles east by 4 miles north of, opposite intersection of T road to west, in base of telephone pole; spike with aluminum tag stamped "95 B. M. 74"	95.34

Parrott schoolhouse northeast to Dayton, thence north to Chico.

Dayton, 3.1 miles west of, 100 feet east of slough, south side of road, in base of telephone pole; spike with aluminum tag stamped "110 B. M. 32"	108.64
Dayton, 2.8 miles west of, south side of road, opposite large barn, 0.5 mile west of Butte City road, in base of 36-inch oak tree; spike with aluminum tag stamped "116 B. M. 33"	115.64
Dayton, 2.2 miles west of, south side of road, northeast corner of field at intersection of Butte City-Dayton roads; iron post stamped "119 B 1909 B. 9"	119.032
Dayton, 0.7 mile southwest of, where road jogs to south and west, east end of gate to ranch, in base of 40-inch oak tree; spike with aluminum tag stamped "131 B. M. 6"	131.13
Dayton, west end of town, 100 feet west of large gate to lane, south side of road, in base of telephone pole; spike with aluminum tag stamped "137 B. M. 5"	136.78
Dayton, 1 mile east of, southeast corner of field, at crossroads, in base of telephone pole; spike with aluminum tag stamped "141 B. M. 4"	141.12
Chico, 3.7 miles southwest of, north edge of road, at bend in road, in base of telephone pole 1699; spike with aluminum tag stamped "143 B. M. 3".	143.30
Chico, 2.7 miles southwest of, east edge of road, southwest corner of field, at intersection of road to Durham; iron post stamped "155 B 1909 B. 1".	154.986
Chico, 1.9 miles southwest of, north edge of road, 400 feet east of large barn, in base of telephone pole; spike with aluminum tag stamped "165 B. M. 2".	165.27
Chico, 0.9 mile southwest of, north side of road, opposite T road east, south of gate to field, in base of telephone pole; spike with aluminum tag stamped "174 B. M. 1"	174.221
Chico, 0.5 mile south of, on east side of railroad, 5 feet north of milepost 5; iron post stamped "185 B 1902"	184.842

Dayton east to Durham.

	Feet.
Dayton, 1 mile east of, northwest corner of field at crossroads; iron post stamped "142 B 1909 B. 2"	142. 241
Durham, 3 miles west of, south side of T road to south, north end of gate, in base of fence post; spike with aluminum tag stamped "150 B. M. 7"	149. 85
Durham, 2 miles west of, south side of road, at T road north, 50 feet west of cross fence, in base of fence post; spike with aluminum tag stamped "156 B. M. 8"	156. 38
Durham, 1.4 miles west of, east side of road, at intersection of north and south road, in base of 36-inch oak tree; spike with aluminum tag stamped "157 B. M. 9"	158. 02
Durham, 0.9 mile west of, at intersection of road, southwest corner of field, in base of telephone pole; spike with aluminum tag stamped "155 B. M. 10"	154. 89
Durham, in front of station; top of rail	159. 1
Durham, 0.4 mile south of, east of railroad, 270 feet north of milepost 179, 5 feet from telephone pole; iron post stamped "152 B 1902"	152. 288

Sterling Junction northwest to Chico.

Sterling Junction, east edge of road, north edge of railroad right of way, at road crossing, in base of oak tree; spike with aluminum tag stamped "201 B. M. 15"	201. 27
Barber, 1 mile east of, southeast corner of trestle over creek; painted bolthead with aluminum tag stamped "200 B. M. 14"	200. 45

KEEFERS AND NORD 7½′ QUADRANGLES.

Chico northwest along highway to Vina.

Chico, 1.7 miles north of normal school, northwest corner of bridge over Big Chico Creek; painted bolthead with aluminum tag stamped "194 B. M. 51"	194. 34
Big Chico Creek, 0.7 mile northeast of, north edge of road, at turn north, in base of telephone pole; spike with aluminum tag stamped "205 B. M. 52"	203. 74
Chico, 3.3 miles northeast of, west edge of road, at lane to ranch, in base of fence post; spike with aluminum tag stamped "202 B. M. 53"	201. 67
Chico, 3.8 miles northeast of, west edge of road, at intersection of road to west, in base of fence post; spike with aluminum tag stamped "193 B. M. 54"	193. 48
Chico, 4.6 miles northeast of, northwest corner of bridge over Mud Creek, in cap; copper nail with aluminum tag stamped "194 B. M. 55"	194. 04
Chico, 5.3 miles northeast of, east edge of road, at junction of road to east, where road jogs northwest, 50 feet south of gate to second-class road; iron post stamped "249 B 1909 B. 14"	248. 607
Chico, 6.5 miles northeast of, 350 feet south of road to east, at cross-fence line, on summit of ridge, in base of fence post; spike with aluminum tag stamped "293 B. M. 56"	292. 64
Chico, 7.2 miles northeast of, east of road, 20 feet south of intersection of road to Richardson's spring, in base of 20-inch live oak tree; spike with aluminum tag stamped "308 B. M. 57"	308. 14
Junction of Chico and Richardson's Spring roads, 1 mile west of, at east end of gate to second-class road, in base of fence post; spike with aluminum tag stamped "304 B. M. 58"	304. 10

	Feet.
Junction of Chico and Richardson's Spring roads, 2 miles west of, north edge of road, opposite east end of orchard at gate to second-class road, in base of 24-inch oak tree; spike with aluminum tag stamped "233 B. M. 59"	232.80
Chico, 6 miles north of, in sec. 28, T. 23 N., R. 1 W., at T road along south bank of Rock Creek, opposite southeast corner of peach orchard; iron post stamped "227 B 1909 B. 15"	227.202
Shannon ranch, opposite house, north edge of road, in base of 24-inch locust tree; spike with aluminum tag stamped "198 B. M. 60"	199.13
Shannon ranch, 1.2 miles west of, 50 feet north of intersection of Chico-Vina-Cohasset roads, 0.5 mile south of Rock Creek Bridge, in base of power pole; spike with aluminum tag stamped "177 B. M. 61"	177.38
Rock Creek, northwest corner of bridge, in cap; copper nail with aluminum tag stamped "183 B. M. 62"	183.09
Rock Creek Bridge, 1 mile northeast of, 2.5 miles south of Antelope schoolhouse, west edge of road, at second-class road through Shannon ranch; iron post stamped "195 B 1909 B. 16"	195.091
Antelope schoolhouse, 1.5 miles south of, west edge of road, at cross-fence line, in base of fence post; spike with aluminum tag stamped "219 B. M 63"	218.91
Antelope schoolhouse, 50 feet south of southwest corner of school yard, in base of fence post; spike with aluminum tag stamped "261 B. M. 64"	260.76
Antelope schoolhouse, 1 mile north of, west edge of road, southeast corner of field on county line, in base of fence post; spike with aluminum tag stamped "285 B. M. 65"	285.15
Pine Creek, southwest corner of bridge, in cap; copper nail with aluminum tag stamped "293 B. M. 66"	293.04
Live Oak schoolhouse, 0.6 mile north by 0.6 mile west of, 2.6 miles east of triangulation station at Stanford sheep ranch headquarters, south edge of road, where road turns west, in bowlder buried flush with ground; aluminum tablet stamped "283 B 1909 B. 17"	283.068
Stanford sheep ranch headquarters, 1.6 miles east of, south edge of road, at fence corner, in base of fence post; spike with aluminum tag stamped "227 B. M. 67"	227.16
Stanford sheep ranch headquarters, 1 mile east of, north edge of road, in base of fence post; spike with aluminum tag stamped "229 B. M. 68"	228.65
Stanford sheep ranch headquarters, 250 feet southwest of house, 5 feet north of tree; triangulation station; iron post stamped "238 B 1909 B 18"	238.035
Stanford sheep ranch headquarters, 0.8 mile north of, west edge of irrigation ditch, in base of 10-inch willow tree; spike with aluminum tag stamped "258 B. M. 68"	257.90
Stanford sheep ranch headquarters, 1.4 miles north of, 4.4 miles east of Vina, at intersection of east-west road, north end of gate, in gate post; spike with aluminum tag stamped "280 B. M. 69"	279.98
Stanford sheep ranch headquarters, 2.6 miles north of, 3.4 miles east of Vina, opposite house, north side of road, at intersection of north-south road, in base of fence post; spike with aluminum tag stamped "262 B. M. 70"	262.00
Vina, 0.4 mile south of, on east side of railroad, 30 feet north of milepost 204; iron post stamped "202 B 1902"	202.206

CHEROKEE, CLEAR CREEK, DRY CREEK, AND OROVILLE 7½′ QUADRANGLES.

Oroville northwest along highway and electric railroad to Sterling Junction.

Oroville, Southern Pacific Railroad station, 200 feet south of, south side of road, east side of track, 6 feet east of railroad property line post; iron post stamped "205 B 1909 J."	204.824

	Feet.
Oroville, northwest corner of steel bridge over Feather River, in concrete abutment, at end of railing top of bolt head; stamped B, painted "191 B. M. 44"	192.41
Oroville, 0.6 mile north of, at crossroads, in base of signpost "Chico-Cherokee;" spike with aluminum tag stamped "267 B. M. 45"	268.04
Oroville, 1.5 miles north of, 15 feet east of fence line, where power line crosses road, in base of power pole 445; spike with aluminum tag stamped "266 B. M. 46"	267.54
Oroville, 2.6 miles northwest of, northwest corner of field, 250 feet south of large barn, at foot of small ridge; iron post stamped "300B 1909 B 12"	301.735
Oroville, 3.9 miles northwest of, east edge of road, at T road to west, in base of power pole 372; spike with aluminum tag stamped "291 B. M. 47"	291.93
Oroville, 4.8 miles northwest of, east edge of road, in base of power pole pole 21/29; spike with aluminum tag stamped "311 B. M. 48"	312.45
Oroville, 5.8 miles northwest of, at Wick's ranch, at junction of road to northeast, 100 feet east of blacksmith shop; iron post stamped "265 B 1909 B 13"	265.053
Oroville, 6.8 miles northwest of, 1 mile northwest of Wicks, south side of road at intersection of second-class road, in base of fence post; spike with aluminum tag stamped "264 B. M. 49"	264.15
Dry Creek, 1.2 miles southeast of, south side of road, at junction of road to south, in base of fence post; spike with aluminum tag stamped "251 B. M. 50"	251.46
Rio Seco schoolhouse, north of, northwest corner of field, 500 feet east of Dry Creek, at intersection of Marysville-Oroville roads; iron post stamped "190 B 1909 B-10"	189.744
Dry Creek, 1.4 miles northwest of, south side of road, at second-class road, in base of power pole 13/19; spike with aluminum tag stamped "223 B. M. 38"	222.68
Butte Creek, 5.7 miles southeast of, east edge of road, in base of power pole 13/6; spike with aluminum tag stamped "184 B. M. 37"	183.60
Butte Creek, 4.6 miles southeast of, east of road, 100 feet south of bridge over drain, in base of power pole 12/3; spike with aluminum tag stamped "166 B. M. 36"	165.80
Durham, 4 miles east of, at intersection of Durham-Chico-Oroville roads, 10 feet west of signpost; iron post stamped "181 B 1909 B-3"	181.556
Butte Creek, 3 miles southeast of, east edge of road, opposite transforming station on power line, in base of power pole 1; spike with aluminum tag stamped "172 B. M. 35"	171.71
Butte Creek, 1.6 miles southeast of, north edge of road, at junction of Chico-Oroville-Paradise roads, in base of power pole 1/4; spike with aluminum tag stamped "172 B. M. 34"	172.01
Butte Creek, 1.2 miles southeast of, south edge of road, in base of power pole 1/10; spike with aluminum tag stamped "177 B. M. 19"	177.38
Butte Creek, 0.8 mile southeast of, north edge of road, 600 feet east of water trough, in base of 36-inch oak tree; spike with aluminum tag stamped "185 B. M. 18"	184.58
Butte Creek, 30 feet west of approach to bridge, north side of road, in base of power pole 2/18; spike with aluminum tag stamped "191 B. M. 17"	191.44
Carmino, 200 feet north of Northern Electric Railroad station, west edge of county road, 50 feet north of large gate, at junction of Chico-Oroville road; iron post stamped "191 B 1909 B 4"	191.217
Sterling Junction, 0.8 mile south of, seventh telephone pole south of milepost 3, east side of right of way, in base of telephone pole; spike with aluminum tag stamped "203 B. M. 16"	202.87

Oroville west along highway to Tres Vias, thence north to Rio Seco schoolhouse.

	Feet.
Oroville, northeast corner of courthouse, 4.5 feet from ground, in concrete wall; aluminum tablet stamped "173 B 1909 B I"	172.736
Oroville, 2.5 miles west of, at road crossing, reverse curve in Northern Electric Railroad track, in base of telegraph pole; spike with aluminum tag stamped "178 B. M. 16"	177.99
Oroville, 3.5 miles west of, at road crossing, northeast corner of right-of-way fence; iron post stamped "203 B 1909 B H"	203.425
Oroville, 5 miles west of, 1 mile east of Tres Vias, at trestle on Northern Electric Railroad and long fill in embankment, in base of power pole; spike with aluminum tag stamped "169 B. M. 15"	169.39
Oroville, 6 miles west of, 200 feet southwest of Northern Electric Railroad station at Tres Vias, northwest corner of Floral schoolhouse yard; iron post stamped "160 B. M. 1909 B. G."	160.307
Oroville, 7 miles west of, 1 mile west of Northern Electric Railroad station at Tres Vias, north side of road, opposite private roadway to south in base of power pole 1/0; spike with aluminum tag stamped "128 B. M. 14"	128.17
Shippee road, 1.2 miles south of Northern Electric Railroad station, southwest corner of barnyard, in base of power pole; spike with aluminum tag stamped "122 B. M. 43," at intersection of road to east	122.48
Shippee road, Northern Electric Railroad station, north edge of right of way, in base of power pole 19/10; spike with aluminum tag stamped "125 B. M. 42"	125.20
Rio Seco schoolhouse, 0.6 mile west of, 2 miles south of, west of road at T road east, opposite power pole 18/14; iron post stamped "136 B 1909 B 11"	136.474
Rio Seco schoolhouse, 0.6 mile west by 1 mile south of, east edge of roads, in base of power pole 17/10; spike with aluminum tag stamped "153 B. M. 41".	153.29
Rio Seco schoolhouse, 0.6 mile west of, northwest corner of bridge over creek, in cap; copper nail with aluminum tag stamped "162 B. M. 40"	162.28
Rio Seco schoolhouse, east end of gate to school yard, in base of gate post; spike with aluminum tag stamped "182 B. M. 39"	182.43
Rio Seco schoolhouse, 1.4 miles north of, northwest corner of field, 500 feet from Dry Creek, at intersection of Marysville and Oroville roads; iron post stamped "190 B 1909 B–10"	189.744

BIGGS, GRIDLEY, HONCUT, AND PALERMO QUADRANGLES.

Point 7.1 miles northeast of Marysville northeast 10 miles, thence west to Honcut (portion of line).

Nigger Jack Slough, 3.8 miles north of, southeast corner of second-class road to east, in base of fence post; spike with aluminum tag stamped "102 B. M. 66"	101.60
Nigger Jack Slough, 4.9 miles north of east edge of road, at section line, in base of fence post; spike with aluminum tag stamped "106 B. M. 67".	107.26
Honcut, 3 miles northeast of, at junction of roads, opposite schoolhouse, at small gate to school yard, in base of 20-inch oak tree; spike with aluminum tag stamped "137 B. M. 75"	137.03
Honcut, 1.3 miles east of, at intersection of north-south road, west end of old store, at fence line; iron post stamped "116 B 1909 B X"	115.714
Honcut, 0.8 mile east of, northwest corner of bridge over Honcut Creek, in top of cord; spike with aluminum tag stamped "114 B. M. 76"	113.13

Point 2.6 miles north of Wooddrift schoolhouse north and east along road to Palermo.

	Feet.
Wooddrift schoolhouse, 3.2 miles north of, 30 feet south of road running east, 300 feet south of blacksmith shop, east side of road; iron post stamped "78 B 1909 B. B."	77.261
Honcut, at large gate in northwest corner of school yard, in base of gate post; spike with aluminum tag stamped "80 B. M. 6"	79.91
Honcut, 1 mile north of, opposite Yuba dairy ranch, center of road, in base of 30-inch oak tree; spike with aluminum tag stamped "83 B. M. 7"	82.34
Honcut, 2.2 miles north of, west side of road, 350 feet south of barn, in base of 36-inch oak tree; spike with aluminum tag stamped "85 B. M. 8"	84.64
Honcut Creek, north bridge over, northeast corner of; painted bolt head with aluminum tag stamped "80 B. M. 9"	79.36
Honcut Creek, 0.8 mile north of, east side of road, at junction with road running east; iron post stamped "87 B 1909 B. C."	86.338
Honcut Creek, 1.5 miles north of, 150 feet south of road running west, west edge of road, in base of 30-inch oak tree; spike with aluminum tag stamped "92 B. M. 10"	91.90
Central schoolhouse, 300 feet south of, 150 feet south of road leading east, east side of road, in base of 40-inch oak tree; spike with aluminum tag stamped "97 B. M. 11"	96.31
Central schoolhouse, 1.1 miles north of, 4.9 miles east of Gridley, northeast corner of field; iron post stamped "101 B. 1909 B. D."	100.383
Union schoolhouse, 2 miles north of, west side of road, opposite bend, in base of telephone pole; spike with aluminum tag stamped "102 B. M. 47"	101.90
Union schoolhouse, 3 miles north of, west side of road, at bend of road, 1,000 feet north of lane to house, in base of telephone pole; spike with aluminum tag stamped "103 B. M. 48"	103.06
Union schoolhouse, 4.1 miles north of, 4.8 miles southwest of Palermo, west edge of road, at section line, southeast corner of small alfalfa field, 500 feet south of house; iron post stamped "119 B 1909 B. O."	118.895
Union schoolhouse, 4.6 miles north of, 4.3 miles southwest of Palermo, west side of road, at intersection of road to east, in base of telephone pole; spike with aluminum tag stamped "111 B. M. 49"	110.65
Palermo, 3.1 miles west by 0.6 mile south of, center of road, 0.2 mile north of small house, in base of 30-inch oak tree; spike with aluminum tag stamped "127 B. M. 50"	126.31
Palermo, 2.6 miles west of, at intersection of east-and-west road, southwest corner of road, 600 feet west of house; iron post stamped "139 B 1909 B. P."	138.735
Palermo, 1.6 miles west of, 25 feet west of intersection of north-south road, in base of telephone pole; spike with aluminum tag stamped "138 B. M. 51"	137.90
Palermo, 1.1 miles west of, southwest corner of bridge over small creek, in top of cord; bolt head with aluminum tag stamped "154 B. M. 52"	153.29

Honcut Creek east to Honcut, thence north to Oroville.

Honcut Creek, 0.8 mile north of, east side of road, at intersection of road to east; iron post stamped "87 B 1909 B. C."	86.338
Honcut, 2.8 miles west of, northwest corner of bridge over creek, in top of cord; bolt head with aluminum tag stamped "81 B. M. 61"	80.52
Honcut, 2 miles west of, east edge of Western Pacific Railway right of way, at road crossing, in base of telephone pole; spike with aluminum tag stamped "83 B. M. 60"	82.28

	Feet.
Honcut, 1.3 miles west of, south side of road, in base of fence post; spike with aluminum tag stamped "88 B. M. 59"	88.12
Honcut, northwest corner of school building; iron post stamped "106 B 1909 B. S."	106.062
Honcut, north edge of town, east edge of railroad right of way, in base of milepost 137; spike with aluminum tag stamped "99 B. M. 58"	98.89
Honcut, 2 miles north of, east edge of railroad right of way, in base of milepost 138; spike with aluminum tag stamped "100 B. M. 57"	100.00
Honcut, 3 miles north of, east edge of right of way, in base of milepost 139; spike with aluminum tag stamped "112 B. M. 56"	111.95
Palermo, 4 miles south of, at Coxes Lane, 250 feet north of milepost 140, east edge of right of way; iron post stamped "121 B 1909 B.R."	120.704
Palermo, 3 miles south of, southeast corner of trestle, at milepost 141; bolt head with aluminum tag stamped "122 B. M. 55"	121.89
Palermo, 2 miles south of, in base of milepost 142; spike with aluminum tag stamped "131 B. M. 54"	131.02
Hearst, in front of Western Pacific Railway station; top of east rail	139.9
Palermo, 1 mile south of, southeast corner of trestle over creek, opposite milepost 143; bolt head with aluminum tag stamped "149 B. M. 53"	149.01
Palermo, in front of Southern Pacific Railroad station; top of rail	154.6
Palermo, southwest corner of brick schoolhouse, 5 feet above ground; aluminum tablet stamped "170 B 1909 B. Q."	169.287
Oroville, Southern Pacific Railroad station, 4.8 miles south of, 0.5 mile north of Palermo Station, 20 feet south of signboard 143/C, south of road crossing and east side of track, in base of telegraph pole; spike with aluminum tag stamped "161 B. M. 21"	160.87
Oroville, 3.7 miles south of, along railroad track, at first road crossing south of Villa Verona, in corner of right-of-way fence; iron post stamped "205 B 1909 B. K."	205.291
Oroville, 2.5 miles south of, on west side of railroad track, in base of telegraph pole; aluminum tag stamped "221 B. M. 20"	220.81
Oroville, Southern Pacific Railroad station, 1.5 miles south of, east side of right of way, in base of telegraph pole; spike with aluminum tag stamped "198 B. M. 19"	197.78
Oroville, Southern Pacific Railroad station, 1 mile south of, east side of track, in base of signboard "Station 1 mile;" spike with aluminum tag stamped "178 B. M. 18"	177.87
Gridley, east 4 miles, thence north by road and electric railroad to Tres Vias.	
Gridley, in front of station; top of rail	92.9
Gridley, 50 feet east of railroad track, south of road, 500 feet south of station, in base of telephone pole 15; spike with aluminum tag stamped "90 B. M. 15"	89.93
Gridley, 0.7 mile east of, south of road, opposite brown house; in base of 40-inch oak tree; spike with aluminum tag stamped "94 B. M. 14"	93.73
Gridley, Northern Electric Railroad crossing at station; top of east rail	97.6
Gridley, 1.8 miles east of, center of north-south road, 1,500 feet east of Northern Electric Railroad, in base of 40-inch oak tree; spike with aluminum tag stamped "94 B. M. 13"	93.04
Gridley, 1.8 miles east of by 1.2 miles north of, 500 feet east of Oro Rancho station on Northern Electric Railroad, in base of 60-inch oak tree; spike with aluminum tag stamped "98 B. M. 77"	97.74
Oro Rancho, 0.4 mile northeast of, 30 feet north of Butte County canal, at Allen ranch, in base of telephone pole; spike with aluminum tag stamped "101 B. M. 78"	100.73

	Feet.
Butte County Canal, surface of water; May 5, 1909	95.5
Oro Rancho, 1.4 miles northeast of, west side of road opposite Reed ranch house, in base of gatepost; spike with aluminum tag stamped "99 B. M. 79"	98.943
Biggs, 3 miles east of, 0.3 mile east of Northern Electric Railroad, at intersection of road west, northeast corner of orchard; iron post stamped "109 B 1909 B. Y."	108.884
Hume (Northern Electric Railroad station), road-crossing sign north of road and east side of track, in base of signpost; spike with aluminum tag stamped "110 B. M. 26"	109.76
Tres Vias, 5 miles south of, 1 mile north of Hume, at road crossing, in base of north pole of overhead crossing poles; spike with aluminum tag stamped "114 B. M. 25"	113.96
Tres Vias, 3.9 miles south of, at road crossing, in deep cut, in embankment, on north side of road, in base of post of cattle guard; spike with aluminum tag stamped "129 B. M. 24"	129.48
Tres Vias, 3 miles south of, at road crossing; iron post stamped "121 B 1909 B. L."	121.004
Tres Vias, 2 miles south of, at road crossing, east side of track, in base of right of way post; spike with aluminum tag stamped "135 B. M. 23"	134.86
Tres Vias, 1.1 miles south of, at road crossing, in base of north pole of overhead crossing poles; spike with aluminum tag stamped "153 B. M. 22"	152.96
Tres Vias, 200 feet south of Northern Electric Railroad station, 6 miles west of Oroville Floral schoolhouse, northwest corner of school yard; iron post stamped "160 B 1909 B. G."	160.307
Biggs east 8 miles.	
Biggs, 1.3 miles north of, west edge of railroad right of way, where wagon road turns west, in base of telephone pole; spike with aluminum tag stamped "91 B. M. 83"	90.32
Biggs, in front of station; top of rail	93.8
Biggs, 1.3 miles east of, southeast corner of intersection of north-south road, in base of telephone pole; spike with aluminum tag stamped "96 B. M. 82"	95.898
Biggs, 2.1 miles east of, southeast corner of bridge over Butte County canal, in bulkhead; spike with aluminum tag stamped "106 B. M. 81"	105.86
Biggs Junction, Northern Electric Railroad station, east line of right of way, in base of telephone pole; spike with aluminum tag stamped "107 B. M. 80"	106.39
Point 3.9 miles east of Gridley west to Feather River.	
Gridley, 3.9 miles east of, northwest corner of steel bridge over slough, in cord; spike with aluminum tag stamped "100 B. M. 12"	98.35
Gridley, 2.7 miles east of, southwest corner of bridge over Feather River, in concrete abutment; aluminum tablet stamped "102 B 1909 B. E."	100.424
Gridley, 2.7 miles east of, on southwest pier of Feather River Bridge; 25-foot mark on water gauge	99.381
Gridley, 2.7 miles east of, surface of water in Feather River, April 22, 1909	85.6
Point 1 mile north of Silsby east and north via highway to point 2 miles west of Tres Vias.	
Silsby, in front of station signpost; top of rail	108.3
Silsby, 1,000 feet south of station signpost, at road crossing, 150 feet east of track, on north side of road, in base of right-of-way fence post; spike, with aluminum tag stamped "102 B. M. 10"	101.85

	Feet.
Silsby, 1 mile east of, small bridge over creek, in floor at west end; copper head with aluminum tag stamped "109 B. M. 11"	108.87
Silsby, 2 miles east of, southeast corner of field, in base of fence post; spike with aluminum tag stamped "108 B. M. 12"	108.43
Silsby, 3.2 miles east of, 8 miles west by 1 mile south of Oroville, at cross-roads, 50 feet north of power pole 22/6; iron post stamped "112 B 1909 B.F."	112.276
Oroville, 8 miles west of, at intersection of county roads and power lines, in base of power pole 21/4; spike with aluminum tag stamped "123 B. M. 13"	123.35
Point 2 miles west of Liveoak south via highway 4 miles.	
Liveoak, 2 miles west of, north side of road, at intersection of north-south road, in base of fence post; spike with aluminum tag stamped "71 B. M. 29"	71.28
Liveoak, 2.8 miles west of, 4 miles north of Union schoolhouse, east side of road, at section corner, in base of fence post; spike with aluminum tag stamped "70 B. M. 46"	70.46
Union schoolhouse, 3.2 miles north of, 1 mile east of, north side of road, 10 feet east of bridge over drain, in base of fence post; spike with aluminum tag stamped "69 B. M. 45"	68.04
Union schoolhouse, 2 miles north by 1 mile east of, north edge of road, at section line, 500 feet east of small house; iron post stamped "65 B 1909 B. N."	64.884
Gridley west and south to Liveoak (portion of line).	
Gridley, 1 mile west of, south side of road, at corner of road leading south, in base of power pole; spike with aluminum tag stamped "87 B. M. 16"	86.85
Gridley, 1.5 miles west of, south of road, at junction of road south, in base of telephone pole; spike with aluminum tag stamped "85 B. M. 17"	84.59
Gridley, 2.8 miles west of, 200 feet west of place where telephone line crosses to north side of road, north edge of road, at section line; iron post stamped "81 B 1909 B. F."	81.048
Liveoak, 4 miles west of, 3.7 miles southeast of Pennington, south side of road, opposite small house, 15 feet east of gate; iron post stamped "72 B 1909 B. J."	71.769
Liveoak, 3.3 miles west of, on southwest corner of concrete culvert over drain; chisel point painted "72 B. M. 28"	72.24
Liveoak, 2.3 miles west of, north side of road, at intersection of north-south road, in base of fence post; spike with aluminum tag stamped "71 B. M. 29"	71.28
Liveoak, 1.4 miles west of, south side of road at intersection of north-south road, in base of telephone pole; spike with aluminum tag stamped "73 B. M. 30"	73.09
Liveoak, opposite north end of large warehouse, west edge of railroad right of way, 25 feet south of railroad crossing, in base of telephone pole; spike with aluminum tag stamped "74"	74.25

Etna Mills, Hoopa, Preston, Sawyer Bar, Seiad, and Yreka quadrangles.

HUMBOLDT AND SISKIYOU COUNTIES.

The elevations in the following list are based upon bench marks at Montague, Hornbrook, and Hoopa, and upon mean sea level datum in agreement with elevations given in Bulletin 342, in which bulletin

are published additional elevations in Yreka quadrangle and vicinity. The prism level and yard rods were used on this work, and certain large errors in the field computations account for the discrepancies between stamped and published elevations.

The leveling was done by L. F. Biggs in 1907, except for a portion of the work in the Hoopa quadrangle done by him in 1906. The descriptions of the bench marks established in 1906 are here republished from Bulletin 342 in order to complete the list. The work was not in cooperation with the State.

YREKA QUADRANGLE.

Montague west along road via Yreka and Forest House to Fort Jones.

	Feet.
Montague, 1 mile south of, east of railroad, second telegraph pole north of milepost 376; iron post stamped "2518 B 1902"	2,518.845
Montague, 1.5 feet west of northeast corner of Montague Hotel; aluminum tablet stamped "B-B-1907-2538"	2,537.665
Montague, 1.7 miles west of, at northwest corner of Shasta River Bridge, 2 feet above abutment, 1 foot below aluminum tag; bolt head with aluminum tag stamped "B-2-2455"	2,455.07
Yreka, high school, in stone foundation of left pillar of east approach; aluminum tablet stamped "B-B-1907-2-2616"	2,615.926
Yreka, courthouse and jail, in cement foundation of northeast corner of jail; aluminum tablet stamped "B-B-1907-3-2625"	2,624.886
Yreka, 4.6 miles southwest of, 0.2 mile east of Forest House, 10 feet north of road, in cut slate ledge; aluminum tablet stamped "B-B-1907-4-3056'.	3,056.010
Summit of divide between Yreka and Fort Jones, 400 feet east of, north edge of road, in slate bowlder 3 by 3 by 3 feet; aluminum tablet stamped "B-B-1907-5-4117"	4,117.440
Summit of divide between Yreka and Fort Jones, 20 feet south of road, in base of pine tree 36 inches in diameter; spike with aluminum tag stamped "B-13-4159"	4,159.41
Fort Jones, 8 miles northeast of, 6 feet west of road, 6 feet north of creek, in base of alder tree 14 inches in diameter, spike; aluminum tag stamped "B-15-3411"	3,411.55
Fort Jones, 6.8 miles northeast of, 6 feet east of road, in base of pine tree 42 inches in diameter; spike with aluminum tag stamped "B-16-3178"	3,178.83
Fort Jones, 5.5 miles northeast of, 6 feet north of road, at rocky point, in slate ledge; aluminum tablet stamped "B-B-1907-6-2935"	2,936.120
Fort Jones, 4.4 miles northeast of, 250 feet north of schoolhouse, 15 feet north of road, in base of oak tree 36 inches in diameter; spike with aluminum tag stamped "B-17-2916"	2,916.82
Fort Jones, 3.2 miles northeast of, 6 feet south of road, in bowlder; aluminum tablet stamped "B-B-1907-2829"	2,829.300
Fort Jones, 1 mile northeast of, 40 feet east of forks of road leading north, in base of pine tree 36 inches in diameter; spike with aluminum tag stamped "B-20-2771"	2,771.00
Fort Jones, in northwest corner of Berm's brick building used as livery stable; aluminum tablet stamped "B-1907-8-2747"	2,747.365

Yreka west and south via Mount Vernon mine house to Fort Jones.

Yreka, 4.3 miles west of, south of road, 25 feet north of ditch at point of rocks, in large bowlder; aluminum tablet stamped "B-B-1907-72-3107".	3,107.296

	Feet.
Yreka, 7.5 miles west of, north of road at summit, 500 feet west of Mount Vernon mine house, in ledge; aluminum tablet stamped "B-B-1907-73-4435"	4,435.593
Yreka, 10.1 miles west of, north of road, 500 feet east of De Silva ranch, in base of pine tree 24 inches in diameter; nail with aluminum tag stamped "B-223-3475"	3,475.10
Yreka, 11.9 miles west of, north of road at Hi U Gulch, in large bowlder; aluminum tablet stamped "74-B-B-1907-3215"	3,215.090
Fort Jones, 4.5 miles northeast of, north of road, 250 feet west of old shack, in base of pine tree 14 inches in diameter; nail with aluminum tag stamped "B-224-3017"	3,016.83
Fort Jones, 4 miles northeast of, 300 feet west of Dan's ranch house, north of road, at foot of pine tree, in rock ledge; aluminum tablet stamped "B-B-1907-75-2932"	2,934.460
Fort Jones south 8 miles (part of line to Etna Mills).	
Fort Jones, 1 mile southwest of, 20 feet east of lane, in base of pine tree 48 inches in diameter; spike with aluminum tag stamped "B-21-2736"	2,736.05
Fort Jones, 3 miles southwest of, 50 feet east of road, in base of pine tree 48 inches in diameter; spike with aluminum tag stamped "B-23-2746"	2,744.64
Fort Jones, 4 miles southwest of, 20 feet east of road, in base of oak tree 36 inches in diameter; spike with aluminum tag stamped "B-24-2758"	2,756.87
Fort Jones, 6.5 miles southwest of, 7.8 miles north of Etna, northwest corner of schoolhouse, in corner stone; aluminum tablet stamped "B-1907-9-2756"	2,754.800
Etna Mills, 6 miles northeast of, 30 feet west of road, in base of pine tree 24 inches in diameter; spike with aluminum tag stamped "B-26-2808"	2,804.20
Fort Jones southwest 7 miles (part of line to Etna Mills).	
Fort Jones, 1.1 miles south of, bridge over Scott River, above southwest pier; top of bolt with aluminum tag stamped "B-188-2722"	**2,722.10**
Fort Jones, 2.7 miles south of, 30 feet north of big gate in rail fence, east of road, in base of pine tree 36 inches in diameter; nail with aluminum tag stamped "B-189-2735"	**2,735.73**
Fort Jones, 4.7 miles south of, 125 feet east of Kitten Creek schoolhouse, east of road, in base of oak tree 30 inches in diameter; nail with aluminum tag stamped "B-191-2768"	**2,768.06**
Greenview, in center of front wall of Denny Bar Co.'s store; aluminium tablet stamped "B-B-1907-64-2812"	**2,812.000**
Greenview, 1.2 miles south of, west of road, 25 feet west of corner of rail fence, in base of pine tree 24 inches in diameter; nail with aluminum tag stamped "B-192-2803"	**2,803.28**
Hamburg southeast along road to point 5 miles south of Scott Bar.	
Hamburg, 1.6 miles southeast of, in northeast corner of bridge over Scott River; key bolt stamped "B-1582," aluminum tag stamped "B-1582-167"	**1,582.91**
Scott Bar, northeast corner of Simon's warehouse; aluminum tablet stamped "B-B-1907-58-1685"	**1,687.135**
Scott Bar, 5.3 miles south of, west of road, in large bowlder; aluminum tablet stamped "B-B-1707-59-2153"	**2,154.988**
Point 12.8 miles northwest of Fort Jones southeast 4.6 miles.	
Fort Jones, 10.3 miles northwest of, north of road, on large bowlder; chisel point painted "U. S.-179-2737"	**2,736.22**

	Feet.
Fort Jones, 8.2 miles northwest of, north of road, 1,000 feet east of Pinkerton's ranch, in rock ledge; aluminum tablet stamped "B-B-1907-63-2655"	2,653.896

Fort Jones northwest to Meamber School.

Fort Jones, 3.4 miles west of, north of road, opposite house, in base of oak tree 36 inches in diameter; nail with aluminum tag stamped "B-185-2721"	2720.53
Fort Jones, 6.4 miles west of, north of road, at bend, 1,000 feet north of house, in base of pine tree 60 inches in diameter; nail with aluminum tag stamped "B-183-2726"	2725.60

Mouth of Scott River east to Hornbrook.

Mouth of Scott River, 2.3 miles east of, west of road, in base of oak tree 24 inches in diameter; nail with aluminum tag stamped "B-197-1581"	1,582.94
Mouth of Scott River, 3.9 miles east of, north of road, 0.5 mile west of Everill ranch house, in slate ledge; aluminum tablet stamped "B-B-1907-65-1593"	1,595.041
Mouth of Scott River, 5 miles east of, at southeast corner of bridge over Klamath River, top of pier; aluminum tag stamped "B-198-1608"	1,610.48
Oak Bar, 1 mile south of, west of road, in base of pine tree 30 inches in diameter; nail with aluminum tag stamped "B-200-1635"	1,637.17
Oak Bar; surface of water, September, 1907	1,630.00
Oak Bar, 500 feet east of hotel, north of road, in large boulder; aluminum tablet stamped "B-B-1907-66-1660"	1,662.384
Oak Bar, 1.5 miles east of, west of road, in base of madrone tree 30 inches in diameter; nail with aluminum tag stamped "B-202-1683"	1,685.31
Oak Bar, 3.3 miles east of, south of road, at Quigley's Ferry, in base of pine tree 30 inches in diameter; nail with aluminum tag stamped "B-204-1699"	1,700.62
Walker, 1,000 feet west of post office, 10 feet east of road, in boulder; aluminum tablet stamped "B-B-1907-67-1722"	1,724.255
Walker, 100 feet east of post office, in base of oak tree 60 inches in diameter; nail with aluminum tag stamped "B-205-1704"	1,706.27
Walker, 2.5 miles east of, south of road, in base of pine tree 24 inches in diameter; nail with aluminum tag stamped "B-207-1729"	1 730.81
Walker, 3.8 miles east of, north of road, in base of oak tree 40 inches in diameter; nail with aluminum tag stamped "1758"	1,759.96
Walker, 5.2 miles east of, south of road at bend, 10 feet east of dry bed of creek, in large bowlder; aluminum tablet stamped "B-B-1907-1810"	1,812.225
Gottville, south bank of Klamath River at bend of road, in rock ledge; aluminum tablet stamped "B-B-1907-69-1882"	1,907.161
Gottville, 2 miles east of, 6 miles east of ferry landing, west of road, in base of oak tree 30 inches in diameter; nail with aluminum tag stamped "B-212-1858"	1,882.73
Gottville, 3.1 miles east of, south of road at bluff over river, in ledge of rock; aluminum tablet stamped "B-B-1907-70-1951"	1,975.740
Gottville, 5.3 miles east of, 1,000 feet east of junction of roads to Yreka and Hornbrook; north of road, in base of pine tree 20 inches in diameter, nail; aluminum tag stamped "B-214-1948"	1,950.96
Gottville, 6.7 miles east of, north of road, in base of oak tree 10 inches in diameter, nail; aluminum tag stamped "B-215-1963"	1,965.46

	Feet.
Gottville, 8.6 miles east of, steel bridge across Klamath River, in floor; nail.	2,003.00
Gottville, 8.6 miles east of, 25 feet north of bridge over Klamath River, west of road, in rock ledge; aluminum tablet stamped "B-B-1907-71-2003"	2,004.557
Gottville, 10 miles east of, south of road, in base of oak tree 40 inches in diameter; nail with aluminum tag stamped "B-216-2014"	2,015.85
Mouth of Shasta River; water surface, Oct. 2, 1907	2,010.6
Hornbrook, 4.3 miles west of, south of road, in base of oak tree 10 inches in diameter; nail with aluminum tag stamped "B-217-2044"	2,045.65
Hornbrook, 3 miles west of, north of road at junction of road and river trail, in large bowlder; aluminum tablet stamped "B-B-1907-72-2069"	2,071.447
Hornbrook, Klamath River at, under swinging bridge; surface of water Oct. 3, 1907	2,059.00
Hornbrook, 0.8 mile south of, west of railroad, 200 feet south of milepost 394, at fence line; iron post stamped "B-2114-1903"	2,115.298
Hornbrook, 2.2 miles north of, east of railroad, 30 feet north of milepost 397, at fence line; iron post stamped "2306-B-1903"	2,306.975

SEIAD QUADRANGLE.

Cottage Grove northeast along road to Seiad, thence southeast to Meamber schoolhouse.[1]

Cottage Grove, 0.5 mile north of, west of trail, 500 feet north of small stream, in bowlder; aluminum tablet stamped "B-B-1907-42-847"	843.363
Cottage Grove, 1.5 miles north of, east of trail, 1,000 feet west of mouth of Independence Creek, in base of pine tree 24 inches in diameter; nail with aluminum tag stamped "B-113-1057"	1,052.94
Cottage Grove, 2.4 miles north of, east of trail, 1,000 feet north of New York Ravine, in base of pine tree 18 inches in diameter; nail with aluminum tag stamped "B-114-1240"	1,236.56
Cottage Grove, 4.6 miles north of, 25 feet east of trail, 150 feet north of Crawford Creek, 10 feet north of cluster of pine trees, in large bowlder; aluminum tablet stamped "B-B-1907-43-1290"	1,285.965
Cottage Grove, 7 miles north of, at Siskiyou mine, north of trail, on summit of hill 200 feet north of mine, in base of pine tree 36 inches in diameter, nail; aluminum tag stamped "B-117-1619"	1,614.96
Happy Camp, 9.8 miles south of, 40 feet north of bridge over Clear Creek, in country bowlder; aluminum tablet stamped "B-B-1907-44-979"	974.863
Cottage Grove, 11.3 miles north of, east of trail, 200 feet north of cabin, in base of pine tree 10 inches in diameter; nail with aluminum tag stamped "B 119 1036"	1,032.32
Happy Camp, 3.6 miles south of, west of trail, 200 feet south of summit of hill, in bowlder; aluminum tablet stamped "B-B-1907-45-1535"	1,531.026
Happy Camp, 1.2 miles south of, 75 feet north of barn on Gride ranch, in base of oak tree 39 inches in diameter; nail with aluminum tag stamped "B 122 1147"	1,143.13
Happy Camp, southwest corner brick wall of Eclipse saloon; aluminum tablet stamped "B-B-1907-46-1092"	1,088.455
Happy Camp, 2.8 miles north of, west of road, in base of oak tree 14 inches in diameter; nail with aluminum tag stamped "B-127-1194"	1,189.76
Happy Camp, 4.8 miles north of, 100 feet north of summit of hill north of trail, in rock ledge; aluminum tablet stamped "B-B-1907-1727"	1,723.443

[1] On this line a computed gross error of 1 yard between Scott Bar and Meamber schoolhouse was arbitrarily adjusted locally at Wilke's ranch, where another yard error possibly exists.

	Feet.
Happy Camp, 8.7 miles north of, east of road, in large bowlder; aluminum tablet stamped "B–B–1907–48–1232"	1,227.845
Nolton, 2 miles east of, 10 feet north of bunk house on Martin's ranch, in large bowlder; aluminum tablet stamped "B–B–1907–49–1296"	1,291.472
Nolton, 3.9 miles east of, south of road, nail; in base of maple tree 36 inches in diameter, aluminum tag stamped "B–136–1341"	1,336.68
Lowden, in front of schoolhouse, in base of oak tree; nail with aluminum tag stamped "B–139–1386"	1,381.49
Seiad, 0.8 mile south of, east of road, on east bank of Klamath River, in rock ledge; aluminum tablet stamped "B–B–1907–55–1446"	1,448.039
NOTE.—The line crosses here to the south bank of Klamath River.	
Seiad, 3.8 miles east of, north of road, in base of maple tree 36 inches in diameter, nail; aluminum tag stamped "B–162–1437"	1,438.96
Seiad, 6.2 miles east of, south of road, 1,000 feet east of Burhardt's ranch house, in bowlder; aluminum tablet stamped "B–B–1907–56–1514"	1,515.633
Hamburg, 1 mile southeast of, 250 feet east of Willard house, nail in base of oak tree 24 inches in diameter; aluminum tag stamped "B–165–1532"	1,533.54
Hamburg, 1.2 miles southeast of, south of road, 1,000 feet west of mouth of Scott River, in large bowlder; aluminum tablet stamped "B–B–1907–57–1547"	1,548.683
Scott Bar, 8.6 miles southwest of, west of road, 25 feet south of shed at Kleaver ranch, in large bowlder; aluminum tablet stamped "B–B–1907–60–2112"	2,113.660
Scott Bar, 10.9 miles southwest of, east of road, 25 feet north of bridge over Scott River, in large bowlder; aluminum tablet stamped "B–B–1907–161–2233"	2,234.835
Fort Jones, 15 miles west of, west of road, 1,000 feet east of Canyon Creek, on large bowlder; chisel point painted "U. S. 177–2355"	2,357.25
Fort Jones, 12.8 miles west of, 100 feet north of Wilke's ranch house, east of road, on large rock; chisel point painted "U. S.–178–2499"	2,490.27

Lowden north to Watkins, Oreg.

Lowden, 0.8 mile north of, east of road, in base of oak tree 36 inches in diameter; nail with aluminum tag stamped "B–141–1545"	1,541.41
Lowden, 3.7 miles north of, east of trail, at end of wagon road, in base of oak tree 48 inches in diameter; nail with aluminum tag stamped "B–143–1842"	1,838.38
Lowden, 6.2 miles north of, west of trail, 4.1 miles west of summit between Lowden and Eileen, in small quartz bowlder; aluminum tablet stamped "B–B–51–1907–4033"	3,927.926
Lowden, 7.6 miles north of, east of trail, 300 feet east of cabin on Wetzel & Well's claim, in base of fir tree 24 inches in diameter; nail with aluminum tag stamped "B–146–5340"	5,235.98
Eileen, 4.1 miles south of, on summit between Lowden and Eileen, 15 feet north of trail, in slate ledge; aluminum tablet stamped "B–B–1907–52 6189"	6,185.403
Eileen, 2.1 miles south of, 250 feet south of corral, west of trail, in base of fir tree 48 inches in diameter; nail with aluminum tag stamped "150–5446"	5,442.01
Eileen, 1.2 miles south of, 25 feet east of junction of trail to Blue Ledge and Eileen, 250 feet south of Sophia mine, in base of pine tree 36 inches in diameter; nail with aluminum tag stamped "B–152–4765"	4,760.59
Eileen, 0.3 mile south of, 0.3 mile north of Blue Ledge mine, east edge of road, in rock ledge; aluminum tablet stamped "B–B–1907–53–3829"	3,825.352

	Feet.
Eileen, 0.6 mile north of, 250 feet north of bridge over small stream, west of road, in base of sugar pine tree 72 inches in diameter; nail with aluminum tag stamped "B–155–3340"	3,335.51
Hutton, 0.5 mile north of, east of road, 250 feet east of flume, in rock ledge; aluminum tablet stamped "B–B–1907–2127"	2,122.034
Watkins, Oreg., 800 feet south of post office, 150 feet north of Applegate Creek, 570 feet southwest of corner of secs. 35 and 36, T. 40 S., R. 4 W., and secs. 1 and 2, T. 41 S., R. 4 W., 10 feet west of big gate; iron post stamped "B–1904–1849"	1,852.367
Watkins, Oreg., 0.9 mile north of, 4 feet southeast of southeast corner of schoolhouse, in root of tree; nail	1,843.13

PRESTON QUADRANGLE.

Torgerson's ranch north to Cottage Grove.

Somes Bar, 8.8 miles north of, west bank of Klamath River, in base of oak tree 30 inches in diameter; nail with aluminum tag stamped "B–102–661"	656.73
Somes Bar, 11.8 miles north of, south of gulch, 200 feet south of small stream, east of trail, in small bowlder; aluminum tablet stamped "B–B–1907–39–900"	895.588
Somes Bar, 13.2 miles north of, 500 feet north of bridge over Rock Creek, south of trail, in base of oak tree 14 inches in diameter; nail with aluminum tag stamped "B–104–720"	715.34
Somes Bar, 15.8 miles north of, east of trail, 0.5 mile south of corral on top of hill, in base of sugar pine tree 36 inches in diameter; nail with aluminum tag stamped "B–107–1433"	1,429.64
Somes Bar, 17 miles north of, 0.2 mile north of summit of Dillon Mountain, west of trail, in small bowlder; aluminum tablet stamped "B–B–1907–40–1801"	1,797.102
Somes Bar, 19.5 miles north of, 500 feet north of summit between Dillon Creek and Cottage Grove, east of trail, in base of fir tree 36 inches in diameter; nail with aluminum tag stamped "B–110–1261"	1,255.50
Cottage Grove, 1.5 miles south of, 2.1 miles north of Dillon Creek, west of trail, corner of corral at Aubrey's ranch, in large bowlder; aluminum tablet stamped "B–B–1907–41–787"	780.877
Cottage Grove, 1.5 miles south of, river at J. C. Aubrey's ranch; surface of water, August, 1907	750
Cottage Grove, 0.7 mile south of, 21.2 miles north of Somes Bar, east of trail, in base of 12-inch forked madrone tree; nail with aluminum tag stamped "B–111–869"	862.93

ETNA MILLS QUADRANGLE.

Point 6 miles northeast of Etna Mills southwest to Etna Mills, thence north.

Etna Mills, 3.3 miles northeast of, 16 feet north of road, in bowlder; aluminum tablet stamped "B–1907–10–2778"	2,775.356
Etna Mills, 2.2 miles east of, at southwest corner of bridge over Scott River, in floor above pier; spike stamped "B," aluminum tag stamped "B–30–2791"	2,786.89
Etna Mills, 2.2 miles east of, Scott River, under bridge; surface of water, June 14, 1907	2,776
Etna Mills, northeast corner of Blake's hotel in brick wall; aluminum tablet stamped "B–1907–11–2933"	2,930.372
Etna Mills, center of Denny Bar Co.'s store, in front brick wall; aluminum tablet stamped "B–1907–12–2945"	2,942.072

	Feet.
Greenview, 2.4 miles south of, west of road, 25 feet south of Washington district school, in base of pine tree 36 inches in diameter; nail with aluminum tag stamped "B-193-2816"	2,816.49

Etna Mills southwest to Snowden.

Etna Mills, 2 miles southwest of, at forks of road to mill, in base of pine tree 24 inches in diameter; spike with aluminum tag stamped "B-33-3122"	3,117.98
Etna Mills, 3 miles southwest of, north of road, in flat rock; aluminum tablet stamped "B-1907-13-3443"	3,439.800
Etna Mills, 5 miles southwest of, 6 feet north of road, in base of pine tree 36 inches in diameter; spike with aluminum tag stamped "B-35-3864"	3,861.70
Etna Mills, 5.8 miles southwest of, east of road, in granite rock; aluminum tablet stamped "B-1907-14-4243"	4,244.170
Etna Mills, 7.7 miles southwest of, 300 feet north of bridge, 20 feet east of road, in base of fir tree 24 inches in diameter; spike with aluminum tag stamped "B-37-5156"	5,151.25
Etna Mills, 9.4 miles southwest of, 20 feet east of road, at summit between Etna Mills and Sawyer Bar, in slate ledge; aluminum tablet stamped "B-1907-15-5969"	5,965.470
Summit, 2.9 miles west of, on south edge of road, in rock; aluminum tablet stamped "B-1907-16-4190"	4,187.696
Summit, 5 miles southwest of, at north edge of road, 1,500 feet west of small bridge, in base of fir tree 48 inches in diameter; nail with aluminum tag stamped "B-41-3450"	3,446.15

SAWYER BAR QUADRANGLE.

Snowden west along road down Salmon River to Somes Bar.

Snowden, 0.6 mile west of, 400 feet west of bridge, west side of creek, north of road; aluminum tablet stamped "B-17-1907-2979"	2,974.612
Snowden, 2.4 miles west of, in southwest corner of steel bridge; bridge spike with aluminum tag stamped "B-44-2598," spike stamped "B"	2,593.73
Snowden, 5.3 miles west of, 10 feet north of fork in road, in large bowlder; aluminum tablet stamped "B-1907-18-2425"	2,420.440
Sawyer Bar, east end of, north of road, in large slate ledge; aluminum tablet stamped "B-19-1907-2173"	2,171.794
Sawyer Bar, 3.1 miles west of, north of road, in rock ledge; aluminum tablet stamped "B-1907-20-1995"	2,022.460
Sawyer Bar, 6.1 miles west of, north of road, at entrance to small gulch, in granite rock; aluminum tablet stamped "B-1907-21-1787"	1,914.360
Sawyer Bar, 8.9 miles west of, south of road at cut making horseshoe; aluminum tablet stamped "B-B-1907-22-1677"	1,716.340
Sawyer Bar, 10.9 miles west of, south of road, in base of live oak tree 14 inches in diameter; nail with aluminum tag stamped "B-54-1429"	1,456.71
Forks of Salmon, 2.4 miles east of, north of road, 500 feet west of bridge, in rock; aluminum tablet stamped "B-1907-23-1484"	1,511.430
Forks of Salmon, 400 feet east of Bennett's store, north of road, in bowlder; aluminum tablet stamped "B-B-1907-24-1214"	1,241.884
Forks of Salmon, 3.2 miles west of, 400 feet west of old Hyde mine, south of trail, 15 feet from edge of bluff over river, in large bowlder; aluminum tablet stamped "B-B-1907-25-1124"	1,151.340
NOTE.—The line crosses here to the southwest side of Salmon River.	
Forks of Salmon, 5.8 miles west of, 600 feet east of small bridge, south of trail, in large bowlder; aluminum tablet stamped "B-B-1907-26-1208"	1,235.834

	Feet.
Forks of Salmon, 7.8 miles west of, 500 feet north of summit between Forks of Salmon and Buttlers Flat, east of road, in large bowlder; aluminum tablet stamped "B-B-1907-27-2531"	2,555.390
Buttlers Flat, 0.4 mile west of, north of road on edge of bluff, in large bowlder; aluminum tablet stamped "B-B-1907-28-858"	882.250
Buttlers Flat, 1.9 miles west of, south of trail, in base of madrone tree 24 inches in diameter; spike with aluminum tag stamped "B-70-1616"	1,640.58
Buttlers Flat, 3 miles west of, 3.04 miles east of summit between Buttlers Flat and Somes Bar, 15 feet north of trail, in bowlder; aluminum tablet stamped "B-B-1907-29-1779"	1,793.654
Somes Bar, 50 feet west of store; point on rock, painted "501"	525.27

HOOPA QUADRANGLE.

Somes Bar north to Torgerson's ranch.

Somes Bar, 0.9 mile north of, north side of Salmon River, south of trail, in base of madrone tree 18 inches in diameter; nail with aluminum tag stamped "B-93-551"	547.27
Somes Bar, 4 miles north of, west of trail, in base of pine tree 24 inches in diameter; nail with aluminum tag stamped "B-96-1504"	1,499.70
Somes Bar, 4.3 miles north of, east of trail, between two small streams, in bowlder; aluminum tablet stamped "B-B-1907-37-1498"	1,494.113
Somes Bar, 6.7 miles north of, 1.7 miles south of Torgerson's ranch, west of trail, in base of oak tree 24 inches in diameter; nail with aluminum tag stamped "B-99-699"	691.63
Somes Bar, 8.3 miles north of, 150 feet north of corral near bridge over small stream at Torgerson's ranch, in top of large bowlder; aluminum tablet stamped "B-B-1907-38-680"	675.438
Torgerson's ranch, Klamath River; surface of water, August 12, 1907	591

Somes Bar southwest down Salmon River to Witchpec, thence south up Trinity River to point 7.5 miles north of Hoopa.

Somes Bar, 0.2 mile west of, south of trail, in large bowlder; aluminum tablet stamped "B-B-1907-564-30"	588.046
Junction of Salmon and Klamath rivers, 0.5 mile south of, at bend in trail, west of trail, in bowlder; aluminum tablet stamped "B-B-1907-31-503"	526.895
Somes Bar, 3.2 miles west of, north of trail at edge of bluff over Klamath River, in base of oak tree 12 inches in diameter; nail with aluminum tag stamped "B-76-809"	830.73
Orleans, 2.6 miles east of, 500 feet east of Reise's house, west of trail, in large bowlder; aluminum tablet stamped "B-B-1907-32-869"	889.820
Orleans, 1 mile east of, 25 feet east of blacksmith shop at Perche's ranch, north of trail, in base of madrone tree 24 inches in diameter; nail with aluminum tag stamped "B-79-537"	558.28
Orleans, 0.5 mile east of, north of trail, 100 feet east of ford, in large bowlder; aluminum tablet stamped "B-B-1907-33-372"	392.901
NOTE.—The line crosses here to the north side of Klamath River.	
Orleans, 2.3 miles west of, south of trail, in base of madrone tree 6 inches in diameter; nail with aluminum tag stamped "B-81-422"	443.16
Orleans, 5.5 miles west of, north of trail, in bowlder; aluminum tablet stamped "B-B-1907-34-674"	694.887
Orleans, 8.6 miles west of, south of trail, in base of madrone tree 30 inches in diameter; nail with aluminum tag stamped "B-86-396"	417.68
Orleans, 10 miles west of, 25 feet west of bridge over Bluff Creek, west of trail, in large bowlder; aluminum tablet stamped "B-B-1907-35-326"	346.760

	Feet.
Witchpec, 3.5 miles east of, south of trail, in base of tan oak tree 56 inches in diameter; nail with aluminum tag stamped "B–86–381"	402.02
Witchpec, 0.9 mile east of, south of trail, in base of oak tree 24 inches in diameter; nail with aluminum tag stamped "B–90–393"	414.16
Witchpec, 250 feet south of Rippey's house, 20 feet south of trail, 900 feet north of junction of Klamath and Trinity rivers, in large bowlder; aluminum tablet stamped "B–B–1907–36–346"	366.950
NOTE.—The line here crosses to the south side of Klamath-Trinity River.	
Hoopa, 7.5 miles north of, west edge of trail, in slate rock; aluminum tablet stamped "B–B–25–1906"	1,006.208
NOTE.—The remaining bench marks in this list are republished from Bulletin 342.	
Point near China Flat along road to Hoopa.	
China Flat, 6.3 miles north of, on west edge of road, in rock; aluminum tablet stamped "B–B–21–1906"	1,354.915
Hoopa, 2.4 miles south of, 1,300 feet south of mile tree 63, 1,700 feet north of bridge, on west edge of road, in bowlder; aluminum tablet stamped "B–B–22–1906"	386.042
Hoopa, 1,000 feet north of Bigard's store, in right edge of steps to United States Indian agent's office; aluminum tablet stamped "B–B–1906–23–352"	351.270
Hoopa north along road and trail 7.5 miles (single spur line).	
Hoopa, 3.2 miles north of, 150 feet south of Soctish Creek, west edge of road, in rock; aluminum tablet stamped "B–B–24–1906"	308.482
Hoopa, 7.5 miles north of, on west edge of trail, in slate rock; aluminum tablet stamped "B–B–25–1906"	1,006.208
Hoopa southwest along trail and road, to forks of road 3.4 miles northwest of Berry ranch house.	
Hoopa, 3.8 miles west of, 20 feet west of Fourmile Creek, in large bowlder; aluminum tablet stamped "B–1906–1716"	1,715.199
Hoopa, 6 miles west of, 10 feet south of trail, in bowlder; aluminum tablet stamped "B–1906–27–2899"	2,900.323
Bear's ranch, 4.5 miles east of, on north edge of trail, in highest point of rock; aluminum tablet stamped "B–1906–28–3495"	3,494.856

Capitola, Morgan Hill, New Almaden, Pajaro, Point Sur, Salinas, San Jose, and Santa Cruz quadrangles.

ALAMEDA, MONTEREY, SAN MATEO, SANTA CLARA, AND SANTA CRUZ COUNTIES.

The elevations in the following list are based upon an adjusted height at San Jose published in Bulletin 342, and accord with precise leveling along the Southern Pacific Railroad main line published in the same bulletin.

Leveling in all of these quadrangles, except Point Sur, was done in 1908 by B. A. Jenkins. Additional work was done in the Salinas quadrangle in 1908 by T. H. Moncure, in the San Jose quadrangle in 1909 by L. F. Biggs, and in 1903 by S. E. Blout, and in the New Almaden and Santa Cruz quadrangles in 1899 by C. C. Ward. The leveling in Point Sur quadrangle was done in 1909 by L. F. Biggs.

The work of 1908 and 1909 was done in cooperation with the State.

CAPITOLA 15′ QUADRANGLE.

Watsonville northwest and west along Southern Pacific Railroad to Del Mar.

	Feet.
Watsonville, 20 feet east of mansion house, north of street, opposite city square brick building; aluminum tablet stamped "S. F. 33 1908 20"...	32.369
Endicott, 1.9 miles south of, in east end of culvert "G-105;" aluminum tablet stamped "S. F. 66 1909 21".....	65.741
Aptos, 4.9 miles south of, 200 feet north of milepost 108, in west end of culvert; aluminum tablet stamped "S. F. 75 1908 22".....	74.484
Aptos, 1 mile south of, east end of culvert 111-F; aluminum tablet stamped "S. F. 104 1908 23".....	103.928
Aptos, 1,400 feet south of station, east of track, in south abutment of new steel bridge; aluminum tablet stamped "S. F. 99 1908 24".....	98.233
Aptos, in front of station; top of rail.....	107.4
Capitola, 0.5 mile south of, on culvert 115, east end; chiseled circle painted "U. S. 88 B. M. No. 42".....	87.70
Capitola, in front of station; top of rail.....	64.8
Capitola, 0.3 mile north of, east of track, north end of new steel bridge, in cement abutment; aluminum tablet stamped "S. F. 55 1908 25".....	54.724
Capitola, 0.8 mile north of, on east end of culvert 116-B; chiseled circle painted "U. S. 63 B. M. No. 43".....	62.32
Del Mar, in front of station; top of rail.....	58.9

SANTA CRUZ 30′ QUADRANGLE.

Del Mar west to Santa Cruz, thence north 3 miles.

Seabright, in front of station; top of rail.....	46.8
Santa Cruz, 0.9 mile north of station, at southeast corner of San Lorenzo River bridge, in guard rail; bolt head painted "U. S. 28 B. M. No. 45"..	28.14
Santa Cruz, 100 feet north of station, in Southern Pacific Railroad grass plot; iron post stamped "S. F. 14 1908 26".....	13.570
Santa Cruz, east side of entrance to Santa Cruz County courthouse, in base of arch; aluminum tablet stamped "S. F. 18".....	17.559
Santa Cruz, northwest corner of brick building facing Pacific Avenue, next building south of courthouse; aluminum tablet stamped "S. F. 18 1908 27".....	17.269
Santa Cruz, 2.8 miles north of, west end of cement culvert; chiseled circle painted "U. S. 170 B. M. No. 47".....	169.50

SAN JOSE 15′ QUADRANGLE.

Irvington south along Southern Pacific Railroad to San Jose.

Milepost 37; iron post stamped "46.563 B".....	46.703
Milepost 40, 350 feet south of, opposite small bridge, east side of track; iron post stamped "11.301 B".....	11.465
Milepost 43, 475 feet south of, at highway crossing, west of track; iron post stamped "37.505 B".....	37.694
Milepost 56, 50 feet east of, east of track; iron post stamped "69.117 B"..	69.330

At San Jose.

San Jose, 150 feet east of Southern Pacific Railroad standard-gage station, in circular base of iron water stand about 2 feet in diameter; log bolt (Coast and Geodetic Survey bench mark).....	91.76
San Jose, southwest corner of St. James and First streets, opposite St. James Square, set horizontally in west end of lower edge of stone banister on north side of entrance to Santa Clara County Hall of Records; aluminum tablet stamped "93 S. F.".....	98.317

San Jose southeast along railroad 8.6 miles.

	Feet.
San Jose, in northeast corner of Trinity Parish Episcopal Church; aluminum tablet stamped "S. F. 98 1908 36"	97.264
San Jose, at 21 North Fourth Street, in southeast corner of brick warehouse and office of Sperry Flour Co.; tablet stamped "S. F. 96 1908 1"	96.111
San Jose, 2 miles south of, 300 feet north of brickworks, west of railroad, in base of semaphore; bolt head painted "U. S. 112 B. M. No. 1"	112.47
San Jose, 3.5 miles south of, 50 feet west of milepost 54, west of track, 400 feet north of Franklin schoolhouse; iron post stamped "S. F. 130 1908 2".	130.490
San Jose, 6.5 miles south of, west of track, 50 feet west of milepost 57; iron post stamped "S. F. 176 1908 B"	175.790
Edenvale, in front of station; top of rail	183.5

San Jose southwest along Southern Pacific Railroad to point 2 miles north of Los Gatos.

San Jose, in front of narrow-gage station; top of rail	96.6
Campbell, in front of station; top of rail	199.7
Campbell, 1.1 miles southwest of, 100 feet east of tank, in cement culvert; aluminum tablet stamped "S. F. 225 1908 35"	224.902
Vasona, in front of station; top of rail	276.1

NEW ALMADEN 15′ QUADRANGLE.

Point 3.6 miles southeast of San Jose to milepost 61.

San Jose, 9.7 miles south of, 800 feet south of milepost 60, 50 feet north of road to Mrs. L. Little's ranch house, where it crosses railroad, at west edge of wagon road; iron post stamped "S. F. 199 1908 4"	198.764
Pomar, in front of station; top of rail	205.1

Point near Zeyante north to point 1 mile north of Los Gatos.

Glenwood, 1.4 miles southwest of, at southwest corner of tunnel 4, in wing; aluminum tablet stamped "S. F. 787 1908 B. O."	786.985
Glenwood, in front of station; top of rail	888.96
Laurel, in front of station; top of rail	899.3
Wrights, 1.4 miles southwest of, at west end of tunnel 2, in wing; aluminum tablet stampde "S. F. 902 1908 31"	901.151
Wrights, 0.2 mile west of station, at northeast end of tunnel 2, in wing; aluminum tablet stamped "S. F. 898 1908 32"	897.847
Aldercroft, 300 feet south of, on northeast corner of cement culvert 60–A; chiseled circle painted "U. S. 731 B. M. No. 61"	730.45
Alma, 0.8 mile southwest of, 400 feet south of private road crossing, west of railroad, in bowlder; aluminum tablet stamped "S. F. 621 1908 B. 3".	620.944
Alma, 0.6 mile northeast of, opposite Lexington, in cement culvert; aluminum tablet stamped "S. F. 535 1908 34"	534.652
Los Gatos, 1.1 miles southwest of, on cement culvert; chiseled circle painted "U. S. 428 B. M. No. 64"	427.76
Los Gatos, opposite station, in east corner of yard around Hotel Lindon, on Santa Cruz Avenue; iron post stamped "S. F. 412"	411.789

MORGAN HILL 15′ QUADRANGLE.

Milepost 61, near Pomar, southeast along Southern Pacific Railroad to Gilroy.

San Jose, 12.5 miles south of, 0.2 mile north of Coyote, 150 feet south of road crossing, opposite milepost 63, west of track; iron post stamped "S. F. 253 1908 5"	253.189

	Feet.
Coyote, in front of station; top of rail	254.7
Coyote, 3 miles south of, 30 feet east of milepost 66, west of road, 150 feet north of railroad crossing; iron post stamped "S. F. 300 1908 6"	300.467
Coyote, 6 miles south of, east of track, 20 feet east of milepost 69, 100 feet west of Madrone post office; iron post stamped "S. F. 344 1908 7"	343.846
Madrone, in front of station; top of rail	347.5
Morgan Hill, in front of station; top of rail	348.2
Morgan Hill, 1.3 miles south of, east of track, 10 feet south of milepost 72; iron post stamped "S. F. 332 1908 8"	332.425
Pennant, in front of station; top of rail	331.0
San Martin, in front of station; top of rail	287.6
Morgan Hill, 4.3 miles south of, east of road, 10 feet east of milepost 75, 500 feet south of Martin schoolhouse; iron post stamped "S. F. 280 1908 9"	279.637
Rucker, in front of station; top of rail	242.0
Gilroy, 2.8 miles north of, 6 feet south of milepost 78, 50 feet south of private road crossing; iron post stamped "S. F. 224 1908 10"	224.445
Gilroy, in southeast corner of city hall; aluminum tablet stamped "S. F. 190 1908 11"	199.963
Gilroy, in Southern Pacific Railroad grass plot, west of track, 100 feet south of station; iron post stamped "S. F. 197 1908 12"	197.016
Gilroy, in front of station; top of rail	196.6

PAJARO 15′ QUADRANGLE.

Gilroy south and west along Southern Pacific Railroad to Watsonville.

Carnadero, in front of station; top of rail	171.5
Gilroy, 3.2 miles south of, 80 feet south of milepost 84, south of track; iron post stamped "S. F. 167 1908 13"	166.653
Miller, in front of station; top of rail	156.5
Gilroy, 6.4 miles south of, 0.2 mile east of Sargent, south of track, 30 feet west of milepost 87; iron post stamped "S. F. 138 1908 14"	137.862
Sargents, in front of station; top of rail	139.2
Sargents, 2.8 miles west of, north of track, 170 feet east of milepost 90; iron post stamped "S. F. 144 1908 15"	144.080
Chittenden, in front of station; top of rail	128.6
Chittenden, 1.7 miles west of, 650 feet west of milepost 93, 900 feet east of rock crusher, south of track; iron post stamped "S. F. 124 1908 16"	123.648
Logan, in front of station; top of rail	117.2
Aromas, in front of station; top of rail	98.2
Chittenden, 4.8 miles west of, south of track, 50 feet south of milepost 96; iron post stamped "S. F. 66 1908 17"	66.227
Vega, in front of station; top of rail	62.6
Pajaro, 1.1 miles east of, 20 feet west of milepost 99; iron post stamped "S. F. 36 1908 18"	36.372
Pajaro, in front of station; top of rail	26.7
Watsonville, 0.5 mile south of, at northeast corner of Pajaro bridge in top of pier; aluminum tablet stamped "S. F. 30 1908 19"	29.567
Watsonville, in front of station; top of rail	26.9

Pajaro south to point 0.6 mile south of Castroville.

Pajaro, 1.8 miles south of, 50 feet west of milepost 102, on line between right of way and county road; iron post stamped "S. F. 19 1908 37"	18.777

	Feet.
Pajaro, 4.8 miles south of, 100 feet north of milepost 105, at east edge of track; iron post stamped "S. F. 3 1908 38"	3.518
Elkhorn, in front of station; top of rail	8.3
Pajaro, 8.1 miles south of, 2.4 miles north of Castroville, 800 feet south of milepost 108, east of track; iron post stamped "S. F. 21 1908 39"	21.091
Castroville, in front of station; top of rail	22.5
Castroville, 0.6 mile south of, 400 feet south of milepost 111, east of track, opposite south end of Y; iron post stamped "S. F. 20 1908 40"	19.519

SALINAS 15′ QUADRANGLE.

Point near Castroville southeast along Southern Pacific Railroad to point 2 miles southeast of Chualar.

Salinas, 5.2 miles northwest of, 20 feet north of milepost 114, east of railroad; iron post stamped "S. F. 28 1908 41"	28.117
Graves, in front of signboard; top of rail	36.6
Salinas, at south end of steps at east entrance to Salinas High School, in cement banister; aluminum tablet stamped "S. F. 53 1908 42"	52.957
Salinas, at west end of steps at south entrance to Monterey County jail, in stone banister; aluminum tablet stamped "S. F. 53 1908 43"	53.413
Salinas, in front of station; top of rail	48.8
Salinas, 200 feet south of station, at north end of Southern Pacific Railroad park; iron post stamped "S. F. 49 1908 44"	49.325
Salinas, 4.6 miles southeast of, 100 feet west of milepost 123, on line between right of way and county road; iron post stamped "S. F. 68 1908 54"	67.986
Spence, in front of station; top of rail	84.3
Spence, 0.6 mile southeast of, 10 feet north of milepost 126; iron post stamped "S. F. 91 1908 53"	90.088
Chualar, 0.2 mile north of station, 20 feet south of road crossing, at north edge of town, on line between right of way and county road; iron post stamped "S. F. 109 1908 52"	108.117
Chualar, in front of station; top of rail	102.2

Salinas north and northwest to Castroville.

Santa Rita, 0.5 mile north of, at road junction; iron post stamped "S. F. 115 1908 45"	115.401
Castroville, 0.7 mile south by 1.7 miles east of, 7.1 miles northwest of Salinas, at north edge of road; iron post stamped "S. F. 61 1908 46"	61.074
Castroville, 0.6 mile south of, 400 feet south of milepost 111, east edge of right of way, opposite south end of Y; iron post stamped "S. F. 20 1908 40"	19.518

Point 3.8 miles north of Salinas east to Natividad, thence south to Spence.

Salinas, 3.8 miles north of, 0.4 mile north of Santa Rita, at road junction; iron post stamped "S. F. 1908 45 115"	115.401
Natividad, 100 feet south of saloon, at fence corner; iron post stamped "S. F. 161 1908 57"	160.809
Natividad, 3.7 miles southeast of, 0.5 mile south of limestone quarry, at angle in road, at east edge of road; iron post stamped "S. F. 185 1908 56".	184.652
Spence, 2 miles northeast by 1 mile north of, at east edge of road; iron post stamped "S. F. 133 1908 55"	132.920

Point 2 miles southeast of Salinas southwest to Spreckles, thence southeast and northeast to Chualar.

	Feet.
Spreckles, 2 miles northeast of, 50 feet south of road junction, north of road, opposite Harkin's ranch house; iron post stamped "S. F. 65 1908 47"...	65.312
Spreckles, office of Spreckles Sugar Co., at south end of steps at main entrance, in cement banister; aluminum tablet stamped "S. F. 62 1908 48".	61.890
Alfred Hansen's ranch house, 3.2 miles northwest of, 100 feet west of forks of road, in fence corner; iron post stamped "S. F. 81 1908 49".....	80.770
Chualar, 2.3 miles southwest by 3.1 miles northwest of, opposite Alfred Hansen's ranch house, at west edge of road; iron post stamped "S. F. 96 1908 50".....	95.053
Chualar, 2.3 miles southwest of, northwest angle of fork road, at west corner of new steel bridge over Salinas River, in cement pier; aluminum tablet stamped "S. F. 90 1908 51".....	89.120

Point near Spreckles southwest and south to Washington School, thence east to Lincoln School, thence northeast to point 2 miles northwest of Hansen ranch house.

Spreckles, 2.25 miles west by 1 mile south of, north of road, opposite second-class road from southeast; iron post stamped "138 104".....	138.224
Spreckles, 3 miles west by 2 miles south of, in center of road, in south side of blazed sycamore tree; painted nail and aluminum tag marked "165 105".....	165.25
Spreckles, near Toro Creek; surface of water in, September 8, 1908.....	215.2
Spreckles, 4.5 miles west by 3 miles south of, in southwest forks of junction of Monterey and Salinas and Corral De Tierra roads; iron post stamped "291 107".....	291.322
Washington school, in yard of, at southeast corner of school; iron post stamped "506 110".....	505.69
Lincoln school, in yard of, at northeast corner of school; iron post stamped "951 113".....	951.418
Divide at head of Pine Canyon, in northwest corner of road forks at divide between Corral De Tierra (valley) and Pine Canyon; iron post stamped "1988 116".....	1,988.568
Pine Canyon, mouth of, 500 feet west of W. V. Brady's ranch house, sharp turn of road around point, on lower side of road; iron post stamped "652 119".....	652.103

Chualar southwest to a point 1.3 miles southeast of Chualar bridge.

Chualar, 2.6 miles west of, 75 feet west of bridge over Salinas River, at intersection of north-south road, at fence line; iron post stamped "100 B 1909 B.3".....	99.631

POINT SUR 30′ QUADRANGLE.

Chualar southwest and southeast to point 4 miles southwest of Soledad (portion of line).

Chualar bridge, 2.4 miles southeast of, 800 feet south of road to west, on east side of road, in base of forked oak tree; copper nail scribed and painted "147 B.M.13".....	147.24
Chualar bridge, 3.5 miles southeast of, west side of road, opposite Wooster house, 0.5 mile north of Somavia schoolhouse; iron post stamped "132 B 1909 B.4".....	132.016

Cape San Martin, Paraiso Springs, Priest Valley, and San Miguel 30′ quadrangles, and Gonzales 15′ quadrangle.

KERN, KINGS, MONTEREY, AND SAN LUIS OBISPO COUNTIES.

The elevations in the following list are based upon precise leveling along the Southern Pacific Railroad.

The greater part of leveling in the quadrangles of this list was done in cooperation with the State in 1908 by W. H. Monahan. Additional leveling was done in 1909 in the Paraiso Springs quadrangle by L. F. Biggs.

GONZALES 15′ QUADRANGLE.

Chualar southeast along Southern Pacific Railroad to point about 1 mile southeast of Gonzales.

	Feet.
Chualar, 1.2 miles southeast of, west of road, 50 feet from railroad, in telephone pole; spike with aluminum tag stamped "108"	107.70
Chualar, 3 miles southeast of, 20 feet north of railroad milepost 132, west of road; iron post stamped "CAL 1908 114 B"	114.220
Chualar, 4 miles southeast of, east of road, 5 feet north of bridge, 50 feet from railroad, in telephone pole; spike with aluminum tag stamped "113"	113.12
Chualar, 5 miles southeast of, west of road, in telephone pole; spike with aluminum tag stamped "117"	117.28
Gonzales, north edge of town, in corner of fence line between main highway and railroad; iron post stamped "CAL 1908 126 B"	125.545
Gonzales, 1 mile southeast of, east of road, 50 feet east of railroad, in telephone pole; spike with aluminum tag stamped "139"	138.97

SAN MIGUEL 30′ QUADRANGLE.

Point 3 miles southeast of San Ardo southeast along railroad to Bradley, thence northeast along highways to Stone Canyon.

San Ardo, 4.3 miles southeast of, east of railroad, in telegraph pole; spike with aluminum tag stamped "461"	460.30
San Ardo, 5.2 miles southeast of, east of railroad, in telegraph pole; spike with aluminum tag stamped "491"	490.17
San Ardo, 6.5 miles southeast of, in base of target 1897; aluminum tablet stamped "1908–493–B"	492.283
San Ardo, 7.3 miles southeast of, west of railroad, in telegraph pole; spike with aluminum tag stamped "501"	500.18
San Ardo, 8.21 miles southeast of, in foundation of relay post; spike with aluminum tag stamped "493"	491.89
San Ardo, 9.2 miles southeast of, west of track, 100 feet from river bank, in telegraph pole; spike with aluminum tag stamped "507"	505.79
San Ardo, 10.1 miles southeast of, in stone culvert under railroad; aluminum tablet stamped "504–B–1908"	503.171
San Ardo, 11.35 miles southeast of, on west side of railroad, in telegraph pole; spike with aluminum tag stamped "518"	517.05
San Ardo, 12.2 miles southeast of, east of railroad, in telegraph pole; spike with aluminum tag stamped "525"	524.34
Bradley, north edge of town, in corner of line fence, 20 feet west of railroad, 1,000 feet north of grain shed; iron post stamped "CAL–1908–541–B"	540.248

	Feet.
Bradley, in front of station; top of rail marked "545"	544.9
Bradley, south edge of town, in corner of fence, 200 feet south of red section house; iron post stamped "552"	552.026
Bradley, 2.8 miles southeast of, north of road, in base of large oak tree; spike with aluminum tag stamped "743"	743.45
Bradley, 4.1 miles southeast of, north of road, at base of hill, in large oak tree; spike with aluminum tag stamped "892"	891.66
Bradley, 4.9 miles east of, north of road, 100 feet east of large oak tree, on line fence; iron post stamped "1026"	1,025.914
Bradley, 6.1 miles east of, south of road, in base of small oak tree; spike with aluminum tag stamped "1256"	1,256.50
Bradley, 8 miles east of, north of railroad, 1,000 feet east of road crossing, in telegraph pole; spike with aluminum tag stamped "1008"	1,007.76
Bradley, 9.1 miles east of, north of railroad, 0.5 mile east of the Hamilton ranch dwelling, in telegraph pole; spike with aluminum tag stamped "1074"	1,073.62
Bradley, 10.2 miles east of, south of railroad, 10 feet west of large oak tree; iron post stamped "1125–CAL–1908–B"	1,124.660
Bradley, 11.3 miles east of, north of railroad, 100 feet north of railroad cut and 100 feet south of Indian Creek, in telegraph pole; spike with aluminum tag stamped "1171"	1,170.72
Bradley, 13 miles east of, north of railroad, 100 feet north of road crossing, in telegraph pole; spike with aluminum tag stamped "1273"	1,273.18
Bradley, 14.2 miles east of, north of railroad, between highway and railroad, 100 feet east of road and railroad bridge, in telegraph pole; spike with aluminum tag stamped "1343"	1,342.64
Bradley, 15 miles east of, south of road, 100 feet north of railroad and 15 feet south of small oak tree on south side of road, 100 feet north of gulch, 1,800 feet north of oil derrick; iron post stamped "1908–CAL–1432–B"	1,431.805
Bradley, 16.1 miles east of, south of track, 1,000 feet southwest of small house on north side of track, in telegraph pole; spike with aluminum tag stamped "1523"	1,523.21
Bradley, 17.3 miles east of, north of railroad, 150 feet east of gulch on north, in telegraph pole; spike with aluminum tag stamped "1614"	1,614.08
Bradley, 18.3 miles east of, east of railroad, 16 feet north of stream and railroad bridge, 100 feet east of road bridge and small house on west, in telegraph pole; spike with aluminum tag stamped "1695"	1,695.26
Bradley, 20.7 miles east of, 200 feet west of power house at summit of mountain, 200 feet west of elevated railroad, on stone; chiseled square and aluminum tag stamped "2710"	2,710.48
Stone Canyon, south side of mine railroad, 50 feet north of road, 400 feet west of opening of the Stone Canyon Consolidated Coal Co.'s mine, 300 feet north of company store, in large stone; aluminum tablet stamped "1908–CAL–2773–B"	2,773.564

Bradley west along highway 9 miles.

San Ardo, 11.4 miles southeast of, west of railroad, in telegraph pole; spike with aluminum tag stamped "517"	517.05
Jolon, 21.8 miles southeast of, in barnyard of Ed Porter ranch, in large oak tree; spike with aluminum tag stamped "498"	498.23
Jolon, 20.9 miles southeast of, north of road, in telephone pole; spike with aluminum tag stamped "550"	550.18
Jolon, 19.9 miles southeast of, west of road, under large oak tree, 1,000 feet south of ranch house on east; iron post stamped "1908–CAL–597–B"	596.97

	Feet.
Jolon, 18.9 miles southeast of, west of road, 1,000 feet south of white patent wire gate leading to ranch on west, in telephone pole; spike with aluminum tag stamped "632"	632.35
Jolon, 17.2 miles southeast of, east of road, north of white barn at top of grade, in telephone pole; spike with aluminum tag stamped "742"	742.32
Jolon, 16.3 miles southeast of, east of road in angle, in telephone pole; spike with aluminum tag stamped "767"	766.93

CAPE SAN MARTIN 30′ QUADRANGLE.

Point 5 miles north of Jolon along highway south and east to point 9 miles west of Bradley.

San Lucas, 14.7 miles southwest of, at junction of roads, 0.75 mile west of "Lockwood;" iron post stamped "1908–CAL–1104–B"	1,104.089
San Lucas, 16.2 miles southwest of, west of road, in telephone pole; spike with aluminum tag stamped "1014"	1,014.11
San Lucas, 17.1 miles southwest of, north of road, 500 feet from white house at foot of hill, in telegraph pole; spike with aluminum tag stamped "1023"	1,023.16
Jolon, at east edge of town, in forks of roads, 3 feet east of signpost which reads "Bradley 25 miles–Pleyto 14.5 miles–San Lucas 19.5 miles;" iron post stamped "1908–CAL–959–B"	959.100
Jolon, 1.9 miles south of, in field 25 feet west of road, in large oak tree; spike with aluminum tag stamped "924"	924.54
Jolon, 4.9 miles southeast of, west of road, 1,000 feet southwest of white house; iron post stamped "1908–CAL–949–B"	949.350
Jolon, 5.9 miles southeast of, east of road, 700 feet south of where road turns due east to "Lockwood," in telephone pole; spike with aluminum tag stamped "950"	950.41
Jolon, 6.8 miles southeast of, south of road, 1,000 feet west of where road turns due west, in telephone pole; spike with aluminum tag stamped "969"	968.87
Jolon, 8.1 miles southeast of, west of road, in front of house painted brown, in telephone pole; spike with aluminum tag stamped "990"	990.21
Jolon, 8.9 miles southeast of, north of road, 200 feet north of the Patterson ranch house, in telephone pole; spike with aluminum tag stamped "978"	977.77
Jolon, 10 miles southeast of, east of road, under large oak tree at edge of line fence; iron post stamped "1908–CAL–945–B"	945.425
Jolon, 10.9 miles southeast of, east of road, top of grade, in small oak tree; spike with aluminum tag stamped "1058"	1,057.80
Jolon, 12.1 miles southeast of, at base of hill on west side of road, in telephone pole; spike with aluminum tag stamped "1008"	1,008.20
Jolon, 13 miles southeast of, east of road at summit of hill, in automobile danger signpost; spike with aluminum tag stamped "1121"	1,121.34
Jolon, 14 miles southeast of, west of road where road angles to east, in base of telephone pole; spike with aluminum tag stamped "971"	970.89
Jolon, 14.1 miles southeast of, west of road under small oak tree, 10 feet west of road; iron post stamped "1908–CAL–852–B"	852.537

PARAISO SPRINGS 30′ QUADRANGLE.

Gonzales southeast along railroad to point 3.6 miles southeast of San Lucas.

Gonzales, 2.1 miles southeast of, east of road, 50 feet southeast of railroad, in telephone pole; spike with aluminum tag stamped "150"	149.76
Gonzales, 2.98 miles southeast of, west of road at railroad crossing, in corner of fence, 20 feet from railroad; iron post stamped "1908–CAL–158–B"	158.328

	Feet.
Gonzales, 4 miles southeast of, west of road, 50 feet west of railroad, in telephone pole; spike with aluminum tag stamped "170"	170.296
Gonzales, 5 miles southeast of, on west side of road, 50 feet from railroad, in telephone pole; spike with aluminum tag stamped "169"	168.98
Camphora, in corner of fence at angle in road, 75 feet northeast of gray house; iron post stamped "1908–CAL–173–B"	173.146
Camphora, 1.5 miles southeast of, east of road, 50 feet east of railroad, in telephone pole; spike with aluminum tag stamped "170"	169.90
Camphora, 2.5 miles southeast of, east of road, 50 feet from railroad, in telephone pole; spike with aluminum tag stamped "180"	180.22
Soledad, north edge of town, in corner of fence between road and railroad; iron post stamped "1908–185–B"	184.524
Soledad, south edge of town, at fence corner, 30 feet east of railroad track; iron post stamped "1908–CAL–189–B"	189.119
Soledad, 0.3 mile southeast of, at road crossing; top of rail marked "192"	192.33
Soledad, 1.1 miles southeast of, 25 feet east of railroad, in telephone pole; spike with aluminum tag stamped "196"	195.53
Soledad, 3 miles southeast of, west of railroad, in telephone pole; spike with aluminum tag stamped "223"	222.63
Soledad, 3.6 miles southeast of, east of railroad, 300 feet north of milepost 147; iron post stamped "1908–CAL–204–B"	204.142
Soledad, 5 miles southeast of, 5 feet west of track in switch post; spike with aluminum tag stamped "207"	207.03
Soledad, 6 miles southeast of, east of track, 200 feet north of road crossing, in telegraph pole; spike with aluminum tag stamped "211"	210.65
Soledad, 7 miles southeast of, east of railroad, near point of curve, on cement culvert; chiseled square marked "218"	218.26
Soledad, 7.7 miles southeast of, east of railroad, 20 feet south of culvert of highway under railroad, 300 feet east of white schoolhouse; iron post stamped "1908–CAL–224–B"	223.831
Metz, in front of station; top of rail marked "239"	239.32
Metz, 1.1 miles southeast of, west of railroad, in telegraph pole; spike with aluminum tag stamped "248"	247.57
Metz, 1.7 miles southeast of, west of railroad; iron post stamped "1908–CAL–244–B"	243.541
Metz, 3 miles southeast of, west of railroad, near curve and switch, in telegraph post; spike with aluminum tag stamped "244"	243.90
Metz, 5.3 miles southeast of, east of railroad, 1,000 feet north of milepost 158; iron post stamped "1908–260–B"	259.881
Metz, 6.2 miles southeast of, east of railroad, 1,000 feet north of milepost 159, in telegraph pole; spike with aluminum tag stamped "263"	263.229
Metz, 7.1 miles southeast of, east of railroad, 1,000 feet north of milepost 160, in telegraph pole; spike with aluminum tag stamped "271"	270.95
Metz, 8.2 miles southeast of, east of railroad at edge of fence, 1,000 feet north of milepost 161; iron post stamped "CAL–1908–281–B"	280.650
Metz, 9.1 miles southeast of, east of railroad, 1,000 feet north of milepost 162, in telegraph pole; spike with aluminum tag stamped "297"	296.96
Metz, 10.4 miles southeast of, east of railroad, in milepost 163; spike with aluminum tag stamped "325"	324.63
Kings City, in front of station; top of rail marked "337"	336.7
Kings City, corner of Broadway and First Street, in cement walk of the Camino Real hotel; aluminum tablet stamped "335–B"	335.070
Kings City, south edge of town, in corner of line fence west side of railroad, 200 feet south of railroad water tank; iron post stamped "1908–CAL–338–B"	338.228

	Feet.
Kings City, 1.1 miles southeast of, east of railroad, 1,000 feet south of milepost 165, in telegraph pole; spike with aluminum tag stamped "316"..	316.07
Kings City, 2 miles southeast of, east of railroad, 1,000 feet south of milepost 166, in telegraph pole; spike with aluminum tag stamped "315"...	314.81
Kings City, 3 miles southeast of, east of railroad, also switch, 1,000 feet south of milepost 167; iron post stamped "1908-CAL-321-B".....	320.890
Kings City, 3.9 miles southeast of, west of railroad, 1,000 feet south of milepost 168, in telegraph pole; spike with aluminum tag stamped "336"...	335.70
Kings City, 5 miles southeast of, west of railroad, 1,000 feet south of milepost 169, in telegraph pole; spike with aluminum tag stamped "371" ..	370.70
Kings City, 6 miles southeast of, east of railroad, 1,000 feet south of milepost 170, in telegraph pole; spike with aluminum tag stamped "383".....	382.62
Kings City, 6.9 miles southeast of, west of railroad, 5 feet from same at edge of concrete culvert; iron post stamped "1908-CAL-394-B".....	393.613
Kings City, 7.8 miles southeast of, east of railroad, in milepost 172; spike with aluminum tag stamped "393".....	392.94
San Lucas, north edge of town, in fence corner, 40 feet from center of railroad, 200 feet north of road crossing; iron post stamped "1908-CAL-394-B".....	393.985
San Lucas, in front of station; top of rail.....	403.82
San Lucas, south edge of town, in corner of fence, with red house, 10 feet from center of railroad; iron post stamped "1908-CAL-408-"B".....	407.543
San Lucas, 1.6 miles southeast of, west of railroad, 100 feet south of road crossing, in telegraph pole; spike with aluminum tag stamped "407"...	407.300
San Lucas, 2.6 miles southeast of, west of railroad, 100 feet north of block signal, in telegraph pole; spike with aluminum tag stamped "410"....	410.03
San Lucas southwest along highway to point 5 miles north of Jolon.	
San Lucas, 2.2 miles west of, east of road, north of white barn, in telephone pole; spike with aluminum tag stamped "375".....	374.64
San Lucas, 2.9 miles west of, 175 feet west of point where road turns due west for Jolon, in fence post; spike with aluminum tag stamped "452"..	451.76
San Lucas, 4 miles west of, south of road, in telephone pole; spike with aluminum tag stamped "535".....	534.66
San Lucas, 5.3 miles southwest of, in fence corner, 700 feet west of yellow house on right of road; iron post stamped "1908-CAL-652-B".....	652.236
San Lucas, 6.2 miles west of, north of road, in base of white oak tree; spike with aluminum tag stamped "689".....	688.72
San Lucas, 7 miles southwest of, 150 feet south of mud brick house on bank, in telephone pole; spike with aluminum tag stamped "785".....	784.70
San Lucas, 8.1 miles west of, north of road, in telephone pole; spike with aluminum tag stamped "956".....	955.98
San Lucas, 9.3 miles west of, at angle in road, west of road, in telephone pole; spike with aluminum tag stamped "1247".....	1,246.54
San Lucas, 10.1 miles southwest of, west of road, 35 feet south of telephone pole; iron post stamped "1908-CAL-1434-B".....	1,433.663
San Lucas, 10.9 miles southwest of, west of road at forks of road, 100 feet south of summit, in telephone pole; spike with aluminum tag stamped "1673".....	1,673.52
San Lucas, 12.1 miles southwest of, south of road, in telephone pole; spike with aluminum tag stamped "1418".....	1,418.36
San Lucas, 13.2 miles southwest of, south of road, in telephone pole; spike with aluminum tag stamped "1237".....	1,237.06

Kings City northeast along highway 10 miles toward Loanoak.

	Feet.
Kings City, 1 mile northeast of, north of road, in telephone pole; spike with aluminum tag stamped "396"	396.06
Kings City, 2.1 miles northeast of, north of road, in telephone pole; spike with aluminum tag stamped "465"	464.92
Kings City, 2.98 miles northeast of, north of road, at clump of trees, on north, in telephone pole; spike with aluminum tag stamped "483"	483.12
Kings City, 4 miles northeast of, south of road, 1,000 feet east of old barn at curve in road, in telephone pole; spike with aluminum tag stamped "563"	562.96
Kings City, 5 miles northeast of, east of road, 1,000 feet east of white wire gate leading to ranch house in valley; iron post stamped "1908–CAL–664–B"	663.535
Kings City, 7.1 miles northeast of, in fence post on south side of road, west of summit of range; spike with aluminum tag stamped "959"	959.18
Kings City, 7.4 miles northeast of, north of road, at summit of range, in telephone pole; spike with aluminum tag stamped "1048"	1,048.29
Kings City, 8 miles northeast of, in fence post opposite gate leading to road in valley at angle in road; spike with aluminum tag stamped "928"	927.77
Kings City, 9.3 miles northeast of, at base of hill, 100 feet from San Lorenzo Creek, 200 feet east of dam, in fence post; spike with aluminum tag stamped "697"	696.82
Kings City, 10.3 miles northeast of, west of San Lorenzo Creek, 5 feet from base of cottonwood tree, 20 feet from bank of creek; iron post stamped "1908–CAL–723–B"	723.035

Point 0.6 mile southeast of Somavia schoolhouse southeast along county road to a point 4 miles southwest of Soledad.

Somavia schoolhouse, 0.6 mile southeast of, west side of road, in base of live oak tree 40 inches in diameter; copper nail with aluminum tag stamped "143 B. M. 14"	143.38
Somavia schoolhouse, 1.6 miles southeast of, 500 feet south of large barn, in base of 30-inch live oak tree; copper nail scribed and painted "135 B. M. 15"	135.31
Gonzales, 2.9 miles west of, 50 feet west of bridge over Salinas River, northwest corner of intersection of road; iron post stamped "110 B 1909 B–1"	110.281
Gonzales, 2.9 miles west of, 0.8 mile southeast of, at intersection of road to west, in base of fence post; scribed and painted "165 B. M. 3;" spike	164.81
Gonzales, 2.9 miles west by 2.1 miles southeast of, west side of road, at bend, on summit of small ridge, in base of 36-inch live oak tree scribed and painted "208 B. M. 4;" spike	206.97
Gonzales, 2.9 miles west by 3.3 miles southeast of, west edge of road, at section line, in base of fence post scribed and painted "209 B. M. 5;" spike	209.12
Gonzales, 2.9 miles west by 4.9 miles southeast of, east edge of road, at section line, southeast corner of field, in base of 30-inch oak tree scribed and painted "322 B. M. 6;" copper nail	321.72
Gonzales, 2.9 miles west by 5.9 miles southeast of, west edge of road, 0.4 mile north of junction of road to Camphora, in base of fence post scribed and painted "289 B. M. 7;" spike	286.69
Subranis schoolhouse, in southeast corner of school yard, at junction of road to Camphora; iron post stamped "211 1909 B B–2"	211.886

	Feet.
Subranis schoolhouse, 1.1 miles southeast of, south side of road, in base of 40-inch oak tree scribed and painted "159 B. M. 8:" copper nail.....	156. 66
Subranis schoolhouse, 1.9 miles southeast of, east edge of road, north end of gate to second-class road through Spreckles Sugar Co.'s ranch, in base of gatepost scribed and painted "218 B. M. 9;" spike.....	215. 28
Subranis schoolhouse, 2.8 miles southeast of, at J. Whisman's ranch, 5 feet east of mail box, in base of fence post; spike with aluminum tag stamped "194 B. M. 23".....	191. 88
Mission schoolhouse, 0.3 mile northwest of, southwest corner of field, at intersection of road to east; iron post stamped "238 B 1909 B–7".....	235. 091
Mission schoolhouse, 1.3 miles southeast of, east edge of road, at lane to east, in base of gatepost; spike with aluminum tag stamped "210 B. M. 24".....	207. 17

Soledad south up Arroyo Seco Creek to a point 4 miles southwest of Greenfield, thence northeast via Greenfield to Metz.

Soledad, 1 mile south of, 50 feet north of bridge over Salinas River, in base of telegraph pole 3086; spike with aluminum tag stamped "196 B. M. 35"	195. 50
Soledad, 1.7 miles south of, at intersection of King City and Paraiso Hot Spring roads, in base of telegraph pole; spike with aluminum tag stamped "196 B. M. 36".....	195. 30
Soledad, 2.9 miles south of, 0.5 mile south of bridge over Arroyo Seco Creek, at intersection of road; iron post stamped "185 B 1909 B–12".....	184. 744
Soledad, 4.8 miles south of, northwest corner of bridge over canal, in floor; copper nail with aluminum tag stamped "203 B. M. 37".....	203. 30
Soledad, 6.2 miles south of, west edge of road, 250 feet north of grove of trees, at cross fence, in base of fence post; spike with aluminum tag stamped "315 B. M. 38"	315. 21
Soledad, 6.8 miles south of, 25 feet east of intersection of road to west, 0.3 mile south of white barn; iron post stamped "375 B 1909 B–13".....	375. 128
Soledad, 7.7 miles south of, east edge of road, at second-class road, in base of gatepost; spike with aluminum tag stamped "396 B. M. 39".....	395. 80
Soledad, 8.8 miles south of, 0.2 mile north of point where road bends southwest, in base of telephone pole; spike with aluminum tag stamped "378 B. M. 40".....	377. 93
Greenfield, 4.3 miles west of, on section line, 1 mile north of Arroyo Seco Creek; iron post stamped "376 B 1909 B–14".....	376. 160
Greenfield, 2.3 miles southwest of, southeast corner of field, 15 feet south of irrigation canal; iron post stamped "329 B 1909 B–15".....	329. 512
Greenfield, 1.7 miles southwest of, southeast corner of field, 300 feet south of house, 700 feet south of crossroad, in base of fence post; spike with aluminum tag stamped "313 B. M. 42".....	312. 24
Greenfield, 0.6 mile northwest of, at intersection of road, in base of telephone pole 3322; spike with aluminum tag stamped "277 B. M. 43"....	276. 07
Greenfield schoolhouse, at large gate to school yard; iron post stamped "286 B 1909 B–16".....	285. 865
Greenfield, southeast end of town, at crossroad, south end of concrete culvert over irrigation ditch; aluminum tablet stamped "287 B 1909 B–11".....	286. 804
Greenfield, 2 miles northeast of, north edge of road, at second class road to ranch, in base of fence post; spike with aluminum tag stamped "246 B. M. 34".....	243. 73
Greenfield, 0. 9 mile northeast of, east side of road, opposite windmill, in base of fence post; spike with aluminum tag stamped "244 B. M. 33"..	243. 84

Kings City southwest to bridge, thence northwest to Greenfield.

	Feet.
Kings City, 0.9 mile southwest of, in floor of bridge over irrigation ditch; spike with aluminum tag stamped "313 B. M."	312.89
Kings City, 1.9 miles southwest of, 200 feet south of bridge over Salinas River, at intersection of road; iron post stamped "330 B 1909 B–8"	329.812
Kings City bridge, 1 mile northwest of west side of road, in base of telephone pole 3736; spike with aluminum tag stamped "321 B. M. 26"	321.27
Kings City Bridge, 2.1 miles northwest of, west edge of road, in base of telephone pole 3693; spike with aluminum tag stamped "348 B. M. 27"	347.60
Kings City Bridge, 3 miles northwest of, west edge of road, where road turns around steep bluff, 5 feet north of telephone pole 3656; iron post stamped "338 B 1909 B–9"	338.329
Kings City Bridge, 4.2 miles northwest of, west edge of road, in base of telephone pole 3609; spike with aluminum tag stamped "282 B. M. 28"	282.06
Kings City Bridge, 5.3 miles northwest of, west side of road, in base of telephone pole 3565; spike with aluminum tag stamped "308 B. M. 29"	308.08
Kings City Bridge, 6.4 miles northwest of, 3.2 miles southeast of Greenfield, 5 feet north of telephone pole 3520, on line between barn and windmill; iron post stamped "317 B 1909 B–10"	317.045
Greenfield, 1 mile southeast of, in base of telephone pole 3398; spike with aluminum tag stamped "267 B. M. 32"	266.67

Point 1.2 miles southeast of Gonzales northeast to Gloria schoolhouse, thence southeast and southwest to Camphora.

Gonzales, 1.6 miles southeast of, at intersection of road to east, in base of telephone pole; spike with aluminum tag stamped "143 B. M. 15"	143.38
Gonzales, 4.7 miles east by road, west bank of old creek bed, 0.5 mile south of Gloria schoolhouse; iron post stamped "515 B 1909 B–5"	514.836
Gloria schoolhouse, 1.9 miles south of, where road jogs east, opposite house in small grove of trees, in base of 24-inch pine tree; spike scribed and painted "396 B. M. 19"	395.80
Gloria schoolhouse, 3 miles southeast of, northeast corner of field, 500 feet east of barn, where road turns to south; iron post stamped "338 B 1909 B–6"	338.458

Camphora southwest to Subranis schoolhouse.

Camphora, 1.6 miles southwest of, east edge of road, north bank of river, in base of fence post; spike with aluminum tag stamped "147 B. M. 45"	146.67
Camphora, 2.7 miles southwest of, 100 feet north of bend of road, opposite small house, in base of cottonwood tree; spike with aluminum tag stamped "141 B. M. 46"	140.95

Gonzales southwest to Gonzales bridge.

Gonzales, 0.9 mile west of, north end of bridge over canal, in floor; copper nail painted "128 B. M. 1"	127.67
Gonzales, 2.1 miles west of, opposite intersection of road to south, in base of fence post scribed and painted "124 B. M. 2;" spike	124.06

PRIEST VALLEY 30′ QUADRANGLE.

Point 2.6 miles southeast of San Lucas southeast along railroad to point 3 miles southeast of San Ardo.

San Lucas, 4.6 miles southeast of, west of railroad, in telegraph pole; spike with aluminum tag stamped "397"	396.26
San Lucas, 5.6 miles southeast of, east of track, 1,000 feet south of deserted building, in telegraph pole; spike with aluminum tag stamped "408"	406.56

	Feet.
San Lucas, 6.6 miles southeast of, west of railroad, 100 feet south of road crossing; iron post stamped "1908–CAL–429–B"	427.722
San Lucas, 7.5 miles southeast of, west of railroad, 100 feet north of block signal 1805, in telegraph pole; spike with aluminum tag stamped "403".	401.75
San Lucas, 8.6 miles southeast of, west of railroad, in telegraph pole; spike with aluminum tag stamped "419"	417.39
San Ardo, in front of station; top of rail marked "458"	457.0
San Ardo, 0.1 mile southeast of, east of railroad, 1,000 feet south of water tank, in base of target 1833; aluminum tablet stamped "1908 CAL–459–B"	457.718
San Ardo, 1.3 miles southeast of, east of railroad, in telegraph pole; spike with aluminum tag stamped "445"	443.495
San Ardo, 2.3 miles southeast of, east of railroad, in telegraph pole; spike with aluminum tag stamped "445"	443.97
San Ardo, 3.1 miles southeast of, east of track, in culvert under railroad corner; aluminum tablet stamped "466–B"	465.191
From point 10 miles northeast of Kings City along highway east to Loanoak, thence southeast via Priest Valley to Crump's ranch, thence northeast 3.7 miles.	
Kings City, 12.7 miles southeast of, south of road, at ranch house, in gate post leading to straw yard; spike with aluminum tag stamped "820"	820.05
Loanoak, 0.8 mile east of, north of road, in telegraph pole; spike with aluminum tag stamped "925"	924.79
Loanoak, 1.6 miles southeast of, south of road, 500 feet west of Andrew Hopkins's residence, 400 feet west of where road crosses creek, in telephone pole; spike with aluminum tag stamped "945"	944.67
Loanoak, 2.3 miles southeast of, southeast corner of road intersection, 800 feet north of schoolhouse; iron post stamped "1908–CAL–1027"	1,027.138
Kings City, 17.1 miles southeast of, north of road, west of Pet Bengard's ranch dwelling, 5 feet south of creek, in telephone pole; spike with aluminum tag stamped "1029"	1,028.74
Kings City, 18.5 miles southeast of, south bank of Lewis Creek, 500 feet west of Pet Bengard's ranch house, in telegraph pole; spike with aluminum tag stamped "1107"	1,107.30
Kings City, 20.97 miles southeast of, north of road, on bank of Lewis Creek, 25 feet north of where road crosses creek, 500 feet north of Ernest Bengard's residence, in telephone pole; spike with aluminum tag stamped "1300"	1,299.66
Loanoak, 9.4 miles southeast of Kings City, 22.8 miles southeast of, east of road, on fence line of the C. O. T. Co.'s pump station No. 4; iron post stamped "1908–CAL–1404–B"	1,404.467
Kings City, 23.6 miles southeast of, south of road, 500 feet east of Miller & Lux goat ranch, 25 feet south of Lewis Creek, at angle in road, in telephone pole; spike with aluminum tag stamped "1455"	1,454.57
Kings City, 24.7 miles southeast of, 100 feet north of where road crosses creek, in leaning cottonwood tree; spike with aluminum tag stamped "1518"	1,517.65
Kings City, 25.6 miles southeast of, north of road, 10 feet south of Lewis Creek, 600 feet south of schoolhouse, in telephone pole; spike with aluminum tag stamped "1580"	1,579.92
Kings City, 26.8 miles southeast of, on south side of road, 50 feet north of Lewis Creek, 200 feet west of where road crosses creek, in large pine tree; spike with aluminum tag stamped "1669"	1,669.04

	Feet.
Kings City, 27.7 miles southeast of, across creek in San Benito County, on James Bengard's ranch, 50 feet west of creek, in telephone pole; spike with aluminum tag stamped "1725"	1,724.68
Loanoak, 15.3 miles southeast of, on Bengard ranch, in front of residence by side of fence, 20 feet north of barnyard gate; iron post stamped "1908–CAL–1766"	1,765.832
Bengard ranch, 100 feet east of, north of road, in telephone pole; spike with aluminum tags stamped "1843"	1,842.79
Bengard ranch, 2.4 miles east of, north of road, 150 feet east of where road crosses Lewis Creek and enters big cut, in leaning cottonwood tree; spike with aluminum tag stamped "1944"	1,944.07
Bengard ranch, 3.1 miles east of, north of road, 50 feet north of angle in road, 150 feet north of Lewis Creek, in telephone pole; spike with aluminum tag stamped "1988"	1,987.91
Bengard ranch, 5.1 miles southeast of, south of road, 1,000 feet south of white ranch house, 100 feet north of Lewis Creek, where road crosses creek; iron post stamped "1908–CAL–2198"	2,197.909
Bengard ranch, 6.2 miles southeast of, north of road, 500 feet south of Griffin residence, in telephone pole; spike with aluminum tag stamped "2254"	2,254.44
Bengard ranch, 7.4 miles southeast of, north of road, 0.5 mile southeast of Palmer Bros.' store, in telephone pole; spike with aluminum tag stamped "2327"	2,327.56
Bengard ranch, 8.1 miles southeast of, north of road, 200 feet east of gate leading to ranch with white house, in telephone pole; spike with aluminum tag stamped "2372"	2,372.51
Bengard ranch, 9.5 miles southeast of, 300 feet north of Maren's ranch house, in telephone pole; spike with aluminum tag stamped "2490"	2,490.36
Bengard ranch, 10.1 miles southeast of, 20 feet north of road on summit of divide, in base of large oak tree; spike with aluminum tag stamped "2580"	2,579.95
Bengard ranch, 11.3 miles southeast of, north of road under large cottonwood tree; iron post stamped "1908–CAL–2057"	2,057.142
Bengard ranch, 12.1 miles southeast of, north of road, 0.8 mile north of C. O. T. Oil Co.'s pumping station, in pine tree; spike with aluminum tag stamped "1968"	1,968.27
C. O. T. Oil Co.'s pumping station, 0.25 mile southeast of, in telephone pole on north bank of creek, 100 feet north of road; spike with aluminum tag stamped "1863"	1,863.41
C. O. T. Oil Co.'s pumping station, 1 mile southeast of, north of road, in telephone pole; spike with aluminum tag stamped "1794"	1,794.08
C. O. T. Oil Co.'s pumping station, 2.2 miles southeast of, north of road, 20 feet north of creek, in cottonwood tree; spike with aluminum tag stamped "1681"	1,681.01
C. O. T. Oil Co.'s pumping station, 2.6 miles southeast of, south of road under cottonwood tree, 300 feet west of where road crosses creek; iron post stamped "1908–CAL–1661–B"	1,660.88
C. O. T. Oil Co.'s pumping station, 3.96 miles east of, north of road, 100 feet west of gulch, in telephone pole; spike with aluminum tag stamped "1603"	1,603.41
C. O. T. Oil Co.'s pumping station, 4.7 miles east of, north of road, 50 feet north of creek where pipe line crosses creek, in telephone pole; spike with aluminum tag stamped "1528"	1,527.85

	Feet.
C. O. T. Oil Co.'s pumping station, 5.9 miles east of, north of road, 100 feet south of Bennett's ranch house, in telephone pole; spike with aluminum tag stamped "1458"	1,457.60
Crump's ranch, east of road, under oak tree, 25 feet east of entrance to dwellings; iron post stamped "1460–B"	1,459.899
Crump's ranch, 0.8 mile east of, at forks of road, near sign post "Fresno Hot Springs" in base of telephone pole; spike with aluminum tag stamped "1448"	1,448.02
Crump's ranch, 1.5 miles east of, northeast of road at angle to small gulch, in telephone pole; spike with aluminum tag stamped "1544"	1,543.77
Crump's ranch, 3.7 miles east of, north of road, 500 feet west of creek, in telephone pole; spike with aluminum tag stamped "1163"	1,163.31

Coalinga and Panoche 30′ quadrangles; Tracy 15′ quadrangle; Copperopolis, Crows Landing, Holt, Ingomar, Los Banos, Newman, Peters, Stockton, Volta, and Westley 7½′ quadrangles.

FRESNO, MERCED, SAN JOAQUIN, AND STANISLAUS COUNTIES.

The elevations in this list are based on the results of precise leveling along the Southern Pacific Railroad published in Bulletin 342, to which bulletin reference should be made for additional elevations in this area.

Leveling in all the quadrangles of this list except the Copperopolis, Holt, and Peters quadrangles was done in 1908 by W. H. Monahan. Additional work was done in the Coalinga quadrangle in 1903 by W. V. Hardy, in 1907 by J. W. Muller, and in 1908 by L. F. Biggs; in the Stockton, Copperopolis, and Peters quadrangles in 1896 by J. B. Lippincott, and in the Holt and Stockton quadrangles in 1907 by B. A. Jenkins. The State cooperated in the work of 1907 in the Stockton quadrangle and in all work done in 1908.

COALINGA 30′ QUADRANGLE.

Bench mark 4 miles west of Lethent west along Southern Pacific Railroad to Alcalde.

	Feet.
Huron, 4.3 miles northeast of, 50 feet south of track, 3 feet east of telegraph milepost 276; iron post stamped "306 G"	306.166
Huron, schoolhouse, 2.5 feet south of entrance; iron post stamped "380 G".	380.231
Arroya Posa Jhena, 1 mile southwest of, 50 feet south of track, 3 feet east of telegraph mile pole 285; iron post stamped "455 G"	455.147
Ora, 4 miles east of, 50 feet south of track, 8 feet north of wagon road, 5 feet east of telegraph mile pole 290; iron post stamped "569 G"	569.216
Ora, 2.1 miles east of, 50 feet south of track, 5 feet east of telegraph mile pole 292; iron post stamped "606 G"	606.101
Ora, 2.5 feet west of telegraph pole marked with name of station, south of oil tanks, 50 feet south of tracks, 2 feet north of wire fence; iron post stamped "647 G"	647.187
Coalinga, southwest end of station; iron post stamped "671 G". (This bench mark has been moved, but its elevation is not materially changed).	671.152
Coalinga, 1.7 miles southwest of, in mouth of Waltham Canyon, 800 feet north of ranch house, 50 feet south of track, 10 feet northwest of road junction; iron post stamped "716 G"	716.110
Alcalde, 70 feet north of station, between station signboard posts; iron post stamped "852 G"	852.214

Point 1.7 miles southwest of Coalinga north and east to California Limited Oil Co.'s property, thence south to Ora.

	Feet.
Coalinga, 3 miles west of, 20 feet east of road, 120 feet northeast of southwest corner of sec. 30, T. 20 S., R. 15 E.; iron post stamped "No. 1, 1907 G 766"	766.123
Coalinga, 5 miles northwest of, 1 mile north of Associated Oil Co.'s pump plant, 30 feet east of section corner, 10 feet east of road; iron post stamped "824 No. 2, 1907 G"	823.565
Coalinga, 7.5 miles northwest of, 1,000 feet north of big tank house where road crosses summit, 40 feet east of road; iron post stamped "1,244 No. 3, 1907 G"	1,244.256
Coalinga, 8 miles north of, on Oil City road, 50 feet west of large drain, 10 feet southwest of junction of roads; iron post stamped "1,157 No. 4 1907 G"	1,157.562
Coalinga, 12 miles north of, 400 feet south of California Limited Oil Co.'s office, 300 feet north of big machine shops, 10 feet south of road, 2 feet east of fence on section line between secs. 21 and 22, T. 19 S., R. 15 E.; iron post stamped "1,467 No. 5, 1907 G"	1,466.988
Coalinga, 10.5 miles northeast of, on fence line between property of Standard Oil Co. and California Limited Oil Co., on north and south line, south end of fence, top of iron fence post 8 inches in diameter, 4 feet high; painted point; post painted "U.S.B.M. 973"; aluminum tag stamped "973" tacked on post brace	973.12
Coalinga, 9 miles northeast of, 400 feet west of Standard Oil Co.'s pump plant No. 1, 100 feet southwest of large black oil tank, 30 feet southwest of junction of roads; iron post stamped "806 No. 6, 1907 G"	806.343
Coalinga, 6.5 miles northeast of, on road to Standard Oil Co.'s pump plant No. 1, 40 feet south of junction of four roads, 50 feet west of Coalinga and Fresno signboard; iron post stamped "816 No. 7, 1907 G"	816.281
Coalinga, 4 miles northeast of, on road to Standard Oil Co.'s pump plant No. 1, 50 feet west of road; iron post stamped "718 No. 8, 1907 G"	718.470
Ora, 100 feet south of station, 50 feet south of Southern Pacific Railroad track, 400 feet south of Southern Pacific Co.'s big oil tanks, on W. V. Hardy's level line; iron post stamped "647 G"	647.187

Jones ranch northwest to Coalinga.

Jones ranch, 500 feet west of house, at fence corner; iron post stamped "1062 B 1908 50 B"	1,061.093
Kranhagen's ranch, 1.9 miles northwest of, 15 feet east of road; iron post stamped "1117 B 1908 51 B"	1,116.466
Kranhagen's ranch, 4 miles northwest of, 0.8 mile west of L. Kranhagen's house, 30 feet south of section corner at road junction; iron post stamped "923 B 52 B 1908"	922.327
L. Kranhagen's house, 0.9 mile northwest of, 500 feet east of schoolhouse, 50 feet south of creek, south of road; iron post stamped "806 B 1908 B 53"	805.665
Alvis ranch, 0.4 mile northwest of house, 25 feet south of junction of roads; iron post stamped "672 B 1908"	671.558
Coalinga, 5.5 miles southeast of, 20 feet east of road, 25 feet northeast of wash, 350 feet north of cabin, at junction of road; iron post stamped "737 B 1908 B 55"	736.516
Coalinga, 2.5 miles southeast of, at junction of roads, 0.5 mile south of ranch house; iron post stamped "647 B 1908 B 56"	646.322

Point about 5 miles west of Alcalde to Coalinga, thence east and north to point about 13 miles southeast of Hayes.

	Feet.
Crump's ranch, 5.2 miles east of, south of road, 50 feet south of Lewis Creek, in Warthan Canyon; iron post stamped "1076 B 1908 CAL"	1,076.003
Coalinga, 1.7 miles southwest of, in mouth of Warthan canyon, 800 feet north of ranch house, 50 feet south of track, 10 feet northwest of road junction; iron post stamped "716 G"	716.110
Coalinga, in front of station; top of rail	669.8
Ora, 2.5 feet west of telegraph pole marked with name of station, south of oil tanks, 50 feet south of track, 2 feet north of wire fence; iron post stamped "647"	647.187
Ora, 2.1 miles east of, 50 feet south of track, 5 feet east of telegraph mile pole 292; iron post stamped "606 G"	606.093
Ora, 4 miles east of, 50 feet south of track, 8 feet north of wagon road, 5 feet east of telegraph milepost 290; iron post stamped "569 G"	569.202
Ora, 8 miles northeast of, 20 feet west of wagon road, opposite small canyon on right; iron post stamped "648 B 1908 CAL"	648.448
Coalinga, 9 miles northeast of, 400 feet west of Standard Oil Co.'s pump plant No. 1, 100 feet southwest of a large black oil tank, 30 feet southwest of junction of roads; iron post stamped "806 G 1907 No. 6"	806.253
Standard Oil Co. pumping station, 2.8 miles north of, 25 feet east of wagon road, on side of hill; iron post stamped "653 CAL 1908 B"	653.276
T. 19 N., R. 16 E., sec. 2, 10 feet west of wagon road, 250 feet south of the Imperial Co.'s pumping plant; iron post stamped "635 CAL 1908 G"	634.997
Imperial Oil Co.'s pumping station, 4.1 miles north of, at foothill of range, and 10 feet south of wagon road; iron post stamped "503 CAL 1908 G"	502.692
Imperial Oil Co.'s pumping station, 6.4 miles north of, on line fence, 785 feet from southwest corner of Ladd's ranch; iron post stamped "504 CAL 1908 G"	503.941
Ladd's ranch, 3.5 miles northwest of, 1.5 miles northwest of clump of cottonwood trees, opposite large canyon on left; iron post stamped "480 CAL 1908 G"	479.900
Ladd's ranch, 8 miles northwest of, 2,798 feet south of gulch, leading from canyon; iron post stamped "553 CAL 1908 G"	553.260
Ladd's ranch, 11.9 miles northwest of, south edge corner of new barn at base of foothills, on a small plateau, 100 feet north of ravine; iron post stamped "578 CAL 1908 G"	577.969

Crump's ranch south to Stone Canyon.

Stone Canyon, 7.5 miles northeast of, 1,000 feet northeast of G. E. Frame's ranch house, in large oak tree on west side of road; spike with aluminum tag stamped "1341"	1,341.05
Stone Canyon, 5.8 miles east of, on top of mountain 700 feet east of large canyon, on north side of road; iron post stamped "1908–CAL–1699–B"	1,699.199
Stone Canyon, 4 miles east of, south of road, on top of knoll where road turns to left, in base of small oak tree; spike with aluminum tag stamped "2593"	2,593.33
Stone Canyon, 3 miles east of, 5 feet north of road where road leaves underbrush and enters open, in base of small oak tree; spike with aluminum tag stamped "3173"	3,173.07
Stone Canyon, 1.3 miles east of, 10 feet north of road, east of gulch, in base of large oak tree; spike with aluminum tag stamped "2883"	2,882.72

PANOCHE 30′ QUADRANGLE.

Point about 13 miles southeast of Hayes to Jamison ranch, about 8 miles southwest of Los Banos.

	Feet.
Ladd's ranch, 14.9 miles northwest of, 50 feet east of creek, 10 feet east of road leading from Cantua Creek to Chenney ranch: iron post stamped "495 CAL 1908 G"	494.820
T. 15 S., R. 13 E., at corner of SW. ¼ sec. 35; iron post stamped "492 CAL 1908 G"	491.700
Ladd's ranch, 20.1 miles northwest of, between wagon road and creek, 400 feet north of point where road crosses creek; iron post stamped "555 CAL 1908 G"	555.178
Ladd's ranch, 23.2 miles northwest of, west of wagon road leading north from Cantua Creek to Chenney ranch, 100 feet south of point where road crosses ravine; iron post stamped "584 CAL 1908 G"	583.854
Hayes, on road leading from Mendota and Fresno to mouth of big Panoche canyon, 95 feet north of Hayes store, 60 feet south of road, under red gum tree; iron post stamped "503 CAL 1908 G"	502.493
Hayes, 3.9 miles northwest of, near base of foothills, 1 mile east of large canyon and 0.5 mile south of large swale; iron post stamped "616 CAL 1908 G"	616.131
Hayes, 7 miles northwest of, 10 feet west of road leading northwest from Hayes to Avery ranch; iron post stamped "529 CAL 1908 G"	529.014
Little Panoche Creek, 45 feet north of north bank, 1.5 miles northeast of Avery ranch; iron post stamped "407 CAL 1909 G"	406.739
Little Panoche Creek, 3.4 miles northwest of, 10 feet west of wagon road leading north from Avery ranch, near base of foothills; iron post stamped "384 CAL 1909 G"	383.329
Little Panoche Creek, 6.4 miles northwest of, 15 feet west of wagon road, 1,650 feet south of old deserted building, 0.5 mile east of foothills; iron post stamped "341 CAL 1909 G"	**340.704**
Little Panoche Creek, 10 miles northwest of, at forks of road, 75 feet west of San Joaquin & Kings River Canal and irrigation company's projected canal; iron post stamped "150 CAL 1909 G"	**149.940**

INGOMAR, LOS BANOS, AND VOLTA 7½′ QUADRANGLES.

Snelling west to Hopeton, thence south to Amsterdam.

Snelling, 4.5 miles southwest of, at corner of fork with road to north, at fence corner of J. G. Ruddle's ranch; iron post stamped "204 B"	**204.037**
Hopeton, at southeast corner of fork with private road, in front of saloon; iron post stamped "185 B"	**184.986**
Hopeton, 2.2 miles south of, southwest end of bridge over Merced River, west margin of road; iron post stamped "172 B"	**172.245**
Amsterdam, 140 feet west of large warehouse, 10 feet east of station sign-board, 20 feet north of track; iron post stamped "215 B"	**215.156**

Point about 8 miles southwest of Los Banos along highways to Los Banos, thence northwest along Southern Pacific Railroad via Volta and Ingomar to point about 1.4 miles north of Gustine.

Charleston schoolhouse, northeast corner of school yard, at junction of wagon road and canal; iron post stamped "149 G 1909"	**149.136**
Dimwoodie ranch, 100 feet north of, iron gate leading to dwelling and 10 feet north of road, near fence line; iron post stamped "135 CAL 1909 G"	**135.165**
Los Banos, north edge of town, 75 feet west of railroad, opposite creamery, 25 feet south of canal on west side of road; iron post stamped "117 CAL 1909 G"	**116.883**

	Feet.
Los Banos, 2.8 miles north of, east of railroad between road and railroad, on fence line, 150 feet east of milepost 138; iron post stamped "114 CAL 1909 G"	114.096
Volta, in front of station; top of rail marked "104"	103.9
Volta, north end of town, 500 feet northeast of schoolhouse and 25 feet west of track, at base of telegraph milepost 136; iron post stamped "102 CAL 1909 G"	101.850
Volta, 4.2 miles north of, 25 feet west of railroad, at base of telegraph milepost 132; iron post stamped "93 CAL 1909 G"	92.397
Ingomar, 0.2 mile north of, at base of telegraph milepost 130, 25 feet west of railroad; iron post stamped "91 CAL 1909 G"	90.486
Ingomar, 4.2 miles north of, at base of telegraph milepost 126, 25 feet west of railroad; iron post stamped "96 CAL 1909 G"	96.049
Gustine, in front of station; top of rail marked "101"	99.95
Gustine, 1.4 miles north of, 5 feet east of milepost 123, 25 feet west of railroad; iron post stamped "94"	94.181

CROWS LANDING AND NEWMAN 7½′ QUADRANGLES.

Point 1.4 miles north of Gustine along Southern Pacific Railroad via Newman and Crows Landing to Emerald.

Newman, south end of station, 10 feet west of track, 5 feet east of telegraph pole; iron post stamped "88 CAL 1909 G"	87.827
Newman, in front of station; top of rail marked "89"	88.4
Newman, 4.4 miles north of, 5 feet north of telegraph milepost 116, 25 feet east of track; iron post stamped "104 CAL 1909 G"	103.644
Crows Landing, 125 feet east of station, 300 feet south of telegraph milepost 114; iron post stamped "111 CAL 1909 G"	111.185
Crows Landing, in front of station; top of rail marked "111"	112.6
Crows Landing, 3 miles north of, 10 feet north of telegraph milepost 111, 25 feet east of track; iron post stamped "114 CAL 1909 G"	113.351
Emerald, in front of station, top of rail marked "103"	102.8
Emerald, 25 feet east of track, 5 feet north of telegraph pole, with sign reading "Emerald;" iron post stamped "102 CAL 1909 G"	101.940

COPPEROPOLIS, HOLT, PETERS, STOCKTON, TRACY, AND WESTLEY 7½′ QUADRANGLES.

At Stockton.

Stockton, southwest corner of Scott Avenue (south side of Mormon Channel) and Center Street, on north iron doorsill, west end of Cool Corner saloon; "Cool Corner" bench mark	15.633
Stockton, southwest corner of Scott Avenue and Center Street, 18 feet from curb corner and 12 feet north of iron doorsill; iron post stamped "16"	15.973
Stockton, at southeast head of channel, corner of Weber Avenue and Eldorado Street, east of steps at corner post; iron plate	12.714
Stockton, on top of stone post on north side of courthouse and west side of walk	16.1
Stockton, San Joaquin courthouse, in angle of wall at north entrance, west of door and near columns, between north door and first window west of it; bronze tablet stamped "18"	17.953
Stockton, Southern Pacific Railroad passenger station, Milton and Oakland branch; top of rail	18.7

Stockton northeast along Milton road and Southern Pacific Railroad to Peters.

J. B. Marsh's house, at northeast corner of entrance to lean-to; iron post stamped "34"	33.605

Emerald northwest along Southern Pacific Railroad to Tracy.

	Feet.
Emerald, 3.3 miles north of, east of track, 5 feet north of telegraph milepost 105; iron post stamped "111 CAL 1909 G"	110.531
Westley, 200 feet east of, front of station; iron post stamped "86 CAL 1909 G"	85.864
Westley, 3.3 miles north of, 25 feet east of track, 5 feet south of milepost 98; iron post stamped "85 CAL 1909 G"	85.260
Westley, 6.3 miles north of, 25 feet east of track, 5 feet south of telegraph milepost 95; iron post stamped "100 CAL 1909 G"	99.602
Westley, 9.3 miles north of, 25 feet east of track, 10 feet north of telegraph milepost 92; iron post stamped "100 CAL 1909 G"	99.436
Westley, 12.3 miles north of, 25 feet east of track, 10 feet south of telegraph milepost 89; iron post stamped "75 CAL 1909 G"	74.850
Westley, 15.3 miles north of, at Southern Pacific Railroad and Western Pacific Railway crossing; top of rail marked "78"	77.89
Westley, 15.3 miles north of, 75 feet east of Southern Pacific Railroad, 100 feet north of Western Pacific Railway at crossing, 10 feet south of milepost 86; iron post stamped "78 CAL 1909 G"	78.042
Tracy, 18 feet north of milepost 72; iron post stamped "53 927 B" (This bench mark was destroyed and a new one erected by Biggs, 1910.)	53.865

Stockton west along Atchison, Topeka & Santa Fe Railway to Tule switch.

Stockton, in front of station; top of north rail	17.8
Stockton, 5.8 miles west of, 200 feet east of milepost 1127 where levee joins railroad embankment, on levee at fence corner; iron post stamped "1907 9 B 1"	8.805
Holt, 180 feet north of station, at edge of right of way on fence line; iron post stamped "2 1907 B 2"	1.921

Bakersfield, Caliente, Cholame, Huasna, Lost Hills, McKittrick, and Tejon quadrangles.

KERN, KINGS, AND SAN LUIS OBISPO COUNTIES.

The elevations in the following list are based upon the precise-level line from Benicia by C. H. Semper in 1901–2, and are in accord with the elevations given in Bulletin 342.

The leveling was done in the Bakersfield quadrangle in 1903 by L. D. Ryus, in 1908 by L. F. Biggs, and in 1910 by K. W. Trimble; in the Caliente and Tejon quadrangles in 1910 by K. W. Trimble and G. L. Hagman; in the Cholame and Lost Hills quadrangles in 1908 by L. F. Biggs; in the McKittrick quadrangle in 1908 by L. F. Biggs and in 1910 by G. L. Hagman, and in the Huasna quadrangle in 1908 by L. F. Biggs. None of the work was done in cooperation with the State.

BAKERSFIELD QUADRANGLE.

Bakersfield south along Union Avenue road to T. 32 S., Rs. 27 and 28 E.; thence northwest along highways to Connor station.

	Feet.
T. 30 S., R. 28 E., southeast corner of sec. 18, on east side of Union Avenue road at road fork, in base of corner fence post; marked and scribed "U. S. B. M. 372"; nail	372.26

	Feet.
T. 30 S., R. 28 E., southeast corner of sec. 19, in northeast fork of cross-roads, at corner of fence; iron post stamped "363 B"	362.588
T. 30 S., R. 28 E., southeast corner of sec. 30, north side of Union Avenue road, in root of poplar tree; marked and scribed "U. S. B. M. 355"; nail.	354.75
T. 30 S., R. 28 E., southeast corner of sec. 31, in northeast fork of cross-roads, 50 feet north of Greenfield store, in base of corner fence post; marked and scribed "U. S. B. M. 346"; nail	345.91
T. 31 S., R. 28 E., southeast corner of sec. 6, southeast corner of road fork, in base of corner fence post; marked and scribed "U. S. B. M. 338"; nail.	338.28
T. 31 S., R. 28 E., southeast corner of sec. 7, on north side of Union Avenue road, at corner of fence; iron post stamped "330 B"	330.416
T. 31 S., R. 28 E., southeast corner of sec. 18, on east side of Union Avenue road, in base of elm tree near telephone pole; marked and scribed "U. S. B. M. 322"; nail	322.16
T. 31 S., R. 28 E., southeast corner of sec. 19, on west side of Union Avenue road, in northwest corner of crossroads in root of elm tree; marked and scribed "U. S. B. M. 313"; nail	313.13
T. 31 S., R. 28 E., southeast corner of sec. 31, on east side of second-class road, at corner of fence; iron post stamped "297 B"	297.015
T. 31 S., R. 28 E., southwest corner of sec. 31, on east side of road, in base of corner fence post; marked and scribed "U. S. B. M. 300"; nail	300.24
T. 32 S., R. 28 E., southwest corner of sec. 7, in top of center support of bridge over irrigating ditch; marked and scribed "U. S. B. M. 281"; nail	280.56
T. 32 S., R. 28 E., southwest corner of sec. 18, on north-south fence line at north end of gate; iron post stamped "282 B"	281.663
T. 32 S., R. 28 E., southwest corner of sec. 30, on north-south fence line, in base of fence post; marked and scribed "U. S. B. M. 329"; nail	328.73
T. 32 S., R. 28 E., southwest corner of sec. 31, at corner of fence; iron post stamped "352 B"	352.408
T. 32 S., R. 27 E., southwest corner of sec. 36, in base of corner fence post; marked and scribed "U. S. B. M. 345"; nail	344.75
Sicarte Lodge, 2 miles west of, on northwest-southeast fence line, in base of fence post; marked and scribed "U. S. B. M. 295"; nail	295.16
Sicarte Lodge, 3 miles west of, 5 feet north of second-class road along northwest-southeast fence line; iron post stamped "297 B"	296.497
T. 32 S., R. 27 E., southeast corner of sec. 18, on west side of Santa Media Road, in northwest corner of road fork, at corner of fence; iron post stamped "294 B"	294.357
T. 32 S., R. 27 E., southeast corner of sec. 7, in northwest corner of crossroads, in base of corner fence post; marked and scribed "U. S. B. M. 288"; nail.	288.28
T. 32 S., R. 27 E., southeast corner of sec. 6, on east side of Santa Media road, in base of telephone pole; marked and scribed "U. S. B. M. 291"; nail	290.56
Point about 2 miles southeast of Rio Bravo west along Southern Pacific Railroad to point 1.1 miles west of Buttonwillow.	
Milepost 335, 180 feet west of, in base of telephone pole; painted and scribed "U. S. B. M. 322"; spike	321.64
Milepost 337, 180 feet west of, at beginning of railroad curve, in base of telegraph pole; painted and scribed "U. S. B. M. 315"; spike	315.01
T. 29 S., R. 25 E., at southwest corner of sec. 17, 1,300 feet west of milepost 339, at east edge of private road crossing, north edge of railroad right of way, in fence corner; iron post stamped "300 B"	300.541

	Feet.
T. 29 S., R. 24 E., near southeast corner of sec. 14, 1,450 feet west of milepost 341, at north edge of railroad right of way, in base of telegraph pole; painted and scribed "U. S. B. M. 290"; spike	289.79
Bowerbank, 0.8 mile east of, 1,300 feet west of milepost 343, at east edge of road where it crosses railroad, at north edge of right of way, in fence corner; iron post stamped "291 B"	290.607
Bowerbank, 1.5 miles west of, where fence along railroad begins, at north edge of right of way, in base of telegraph pole; painted and scribed "U. S. B. M. 292"; spike	292.64
Milepost 346, 500 feet west of, at east edge of private road where it crosses railroad, at north edge of right of way, in base of telegraph pole; painted and scribed "U. S. B. M. 278"; spike	277.71
Buttonwillow, 0.8 mile east of, 350 feet east of point where main road crosses railroad, at north edge of right of way, in base of telegraph pole; painted and scribed "U. S. B. M. 272"; spike	271.84
Buttonwillow, 165 feet east of station, at north edge of highway, in fence corner; iron post stamped "269 B"	268.893
Kern along Sunset Railroad southwest, west, and northwest, to sec. 36, T. 29 S., R. 25 E.	
Kern, at station, iron post stamped "B"	421.877
T. 30 S., R. 28 E., southeast corner of sec. 6, on west side of Union Avenue road at crossing, north side of railroad right of way; iron post stamped "392 B"	392.296
T. 30 S., R. 27 E., southeast corner of sec. 15, 1.7 miles west of Wibble orchard, at west side of wagon road, at north edge of railroad right of way; iron post stamped "369 B"	369.247
Gosford, in front of station, top of rail	362.0
T. 30 S., R. 27 E., northwest corner of sec. 20, 1.7 miles west of Gosford, at south side of road opposite crossing of road to ranch house; iron post stamped "358 B"	358.551
T. 30 S., R. 26 E., near quarter corner on south side of sec. 15, 1,200 feet west of milepost 328, north edge of right of way; iron post stamped "346 B"	346.813
T. 30 S., R. 26 E., sec. 7, 1.5 miles west of Stevens, 200 feet south of track, at corner of fence, 500 feet west of milepost 331, 20 feet east of gate; iron post stamped "337 B"	337.748
T. 29 S., R. 25 E., south of northwest corner of sec. 36, on east side of county road, north edge of railroad right of way; iron post stamped "327 B"	327.610
Point on Sunset Railroad north along wagon road to Rio Bravo School, thence east to Atchison, Topeka & Santa Fe Railway track.	
T. 29 S., R. 25 E., near quarter corner on east side of sec. 11, at southeast corner of Rio Bravo schoolhouse yard; iron post stamped "332 B"	332.278
T. 28 S., R. 26 E., quarter corner on south side of sec. 32, opposite north corner common to secs. 4 and 5, T. 29 S., north side of wagon road, at west edge of railroad right of way; iron post stamped "339 B"	339.643
Southeast along Atchison, Topeka & Santa Fe Railway to Kern.	
T. 29 S., R. 26 E., near southeast corner of sec. 14, 0.25 mile east of Rosedale, 1 mile north of Rosedale post office, west side of county road, north line of railroad right of way; iron post stamped "360 B"	360.612
T. 29 S., R. 27 E., quarter corner on east side of sec. 29, 4 miles west of Bakersfield, west side of public road, north line of railroad right of way; iron post stamped "387 B"	387.366

Point 1 mile east of Oil triangulation station southwest along road 3 miles, thence southwest across country to point 1 mile southeast of Jewetta.

	Feet.
T. 28 S., R. 27 E., SW. ¼ sec. 25, 1.5 miles north of Standard Oil Co.'s storage reservoirs, east bank of ravine, west side of Bakersfield and Poso Creek road; iron post stamped "730"	730.355

Oil triangulation station southwest across country to sec. 14, T. 28 N., R. 27 E., thence south to point near Jewetta.

T. 28 N., R. 27 E., at center of sec. 14, 2 miles southwest of Oil triangulation station; iron post stamped "864"	864.260

Kern along Southern Pacific Railroad to Gosford Junction, thence southwest along Sunset Railroad to Sunset.

Kern, 130 feet east of northeast corner of station, at south end of road and corner of fence; iron post stamped "421 B"	421.877
Gosford Junction, 2 miles south of, 25 feet west of intersection of roads, 25 feet north of ditch, in base of signal post scribed and painted "351;" nail	351.50
Gosford Junction, 3 miles south of, at road crossing, north of road, east of track, in fence corner; iron post stamped "343 1"	342.975
Gosford Junction, 6 miles south of, 30 feet west of track at section line, 15 feet north of ditch, 0.5 mile south of milepost 15; iron post stamped "320 2"	319.966
Connor, 500 feet east of station, north of track, at corner of secs. 31, 32, 5, and 6, Tps. 31 and 32 S., R. 27 E.; iron post stamped "293 3"	292.962
Connor, in front of station; top of rail	292.6
Connor, 2 miles west of, at corner of secs. 35, 36, 1, and 2, Tps. 31 and 32 S., R. 26 E.; iron post stamped "291 B 1908 4 B"	290.975
Millux, 0.4 mile west of, 25 feet north of track, at corner of secs. 32, 33, 4, and 5, Tps. 31 and 32 S., R. 26 E.; iron post stamped "291 B. 1908 B 5".	290.976
Millux, 2.3 miles west of, 500 feet north of switch from main line along levee of Buena Vista Lake, 250 feet north of milepost 26, 30 feet north of track; iron post stamped "298 B 1908 B 6"	297.892
Buena Vista Lake; surface of water January 9, 1908	290.5
T. 32 S., R. 26 E., 110 feet west of corner of secs. 7, 8, 12, and 13, 2.3 miles west of, by 1.6 miles south of Millux, at road crossing, in base of signal post scribed and painted "299 B. M. 13;" spike	298.74
Millux, 2.3 miles west by 2.9 miles south of, east of track, 200 feet north of bridge 29-A, 10 feet east of third telephone pole east of milepost 29; iron post stamped "314 B 1908 7 B"	312.911
Sunset, 7.3 miles northeast of, south of track, 600 feet south of bridge 32-B, at milepost 32; iron post stamped "409 B 1908 8 B"	408.877
Sunset, 4.4 miles northeast of, 25 feet south of track, at milepost 35; iron post stamped "564 B 1908 9 B"	563.886
Sunset, 1.4 miles northeast of, 25 feet east of track at road crossing, 25 feet north of bridge 38 B; iron post stamped "686 B 1908 10 B"	685.836
Sunset, in front of station; top of rail	766.6
Sunset, at north end of station; iron post stamped "767 B 1908 11 B"	767.431

Sunset west toward Job's ranch.

Sunset, 1.5 miles west of, east of road, on rock painted "938 B. M. 21;" chisel point	937.89
Sunset, 3.9 miles west of, 500 feet west of junction of road to Job's ranch, north of road, on rock painted "1339 B. M. 23;" chisel point	1,339.63
Sunset, 6.6 miles west of, 30 feet south of road, 300 feet west of spring at foot of steep grade, 25 feet west of edge of gulch; iron post stamped "1807 B 1908 12 B"	1,806.589

Sunset northwest toward McKittrick.

	Feet.
Sunset, 1.8 miles northwest of, west of road at railroad crossing; iron post stamped "852 B 1908 38 B"	851.256
Sunset, 5.4 miles northwest of, east of road, 2,000 feet west of old derrick, 100 feet north of drain; iron post stamped "752 B 1908 37 B." (Disturbed, according to letter from R. J. Reed, dated Aug. 9, 1910)	751.750
McKittrick, 15.2 miles southeast of, east of road, at crossroads; iron post stamped "1115 B 1908 36 B." (Disturbed, according to letter from R. J. Reed, dated Aug. 9, 1910)	1,115.06
McKittrick, 12.1 miles southeast of, east of road, 50 feet north of junction, 1,000 feet north of large drain; iron post stamped "1126 B 1908 36 B." (Disturbed, according to letter from R. J. Reed, dated Aug. 9, 1910)	1,125.743

CALIENTE QUADRANGLE.

Point 5 miles east of Edison south along highways to T. 32 S. and T. 12 N., thence west to sec. 32, T. 32 S., R. 28 E.

Edison, 4 miles east by 0.8 mile south of power tower 89; top of east lower brace, painted "U. S. B. M. □ 779" and stamped "779 B □"	778.93
Edison, 4 miles east by 2 miles south of, on top of east lower brace of power tower 99; chiseled square painted "U. S. □ B. M. 724" and stamped "724 B □"	723.82
Edison, 4 miles east by 2.9 miles south of, on power line of Edison Electric Co., just north of point where line goes over hill, 60 feet north of second-class road, 18 feet south of power tower 106; iron post stamped "657 B".	657.303
Edison, 4 miles east by 3.9 miles south of, top of west lower brace of power tower 115, painted "U. S. B. M. □ 596" and stamped "596 B □;" chisel mark	595.61
Edison, 4 miles east by 5 miles south of, on top of east lower brace of power tower 124, painted "U. S. □ B. M. 553;" chisel mark	553.06
Rockpile School, 1 mile west of, on Edison Electric Co.'s power line, 12 feet south of tower 132; iron post stamped "516 B"	516.171
Rockpile School, 1 mile west by 1 mile south of, on top of east lower brace of power tower 140, painted "U. S. □ B. M. 485;" chisel mark	484.96
Rockpile School, 1 mile west by 2 miles south of, on top of east lower brace of power tower 147, painted "U. S. □ B. M. 458;" chisel mark	458.17
Rockpile School, 1 mile west by 3 miles south of, on top of east lower brace of power tower 155, painted "U. S. □ B. M. 429;" chisel mark	429.29
T. 31 S., R. 29 E., southeast corner of sec. 36, 120 feet southeast of Edison Electric Co.'s power tower 163; iron post stamped "409 B"	408.821
Edison Electric Co.'s power tower 171, on north lower brace, painted "U. S. □ B. M. 416;" chisel mark	416.26
Edison Electric Co.'s power tower 179, 200 feet north of road to Tehachapi, on west lower brace, painted "U. S. □ B. M. 474;" chisel mark	473.85
T. 32 S., R. 29 E., near south quarter corner of sec. 10, at east line of north-south road; iron post stamped "442 B"	441.837
T. 32 S., R. 29 E., near north quarter section corner of sec. 27, where telephone line turns east, in base of telephone pole painted and scribed "U. S. B. M. 558;" spike	555.83
T. 32 S., R. 29 E., near south quarter corner of sec. 34, on west margin of second-class north-south road; iron post stamped "561 B"	560.537
T. 32 S., R. 29 E., near south quarter corner of sec. 33, in base of fence post painted and scribed "U. S. B. M. 535;" spike	532.63
T. 32 S., R. 29 E., near south quarter corner of sec. 31; iron post stamped "473 B"	472.929

	Feet.
T. 32 S., R. 28 E., 0.6 mile east of the southeast corner of sec. 33, at northeast margin of county road where it turns south, on fence line; iron post stamped "438 B"	438.077
Sec. 34, T. 32 S., R. 28 E., south along county road to point 3 miles south of Rose station.[1]	
Rose, 10.7 miles north of, on county road, in base of telephone pole 1010, painted and scribed "U. S. B. M. 495;" spike	495.09
Rose, 8.5 miles north of, on county road where it goes through gate, in base of telephone pole at fence corner painted and scribed "U. S. B. M. 635"; spike	635.08
Rose, 7.6 miles north of, in southwest corner of road where it turns east, near fence corner and telephone pole 1142; iron post stamped "711 B"	710.501
Rose, 6.6 miles north of, on county road, in base of telephone pole 1184, painted and scribed "U. S. B. M. 748"; spike	747.66
Rose, 5 miles north of, at northeast corner of T road where telephone line turns south, near telephone pole 1238; iron post stamped "763 B"	763.445
Rose, 2.8 miles north of, on county road, in base of telephone pole 1322, painted and scribed "U. S. B. M. 956"; spike	956.10
Edison Electric Co.'s power tower 179, east along highway via Cummings Valley to point 1.2 miles southwest of Tehachapi.[1]	
Edison Electric Co.'s power tower 179, 1 mile east of, at fence corner where road turns north, in base of fence post painted and scribed "U. S. B. M. 557"; spike	556.63
Edison Electric Co.'s power tower 179, 3.1 miles east of, where road runs around projecting hill, on north side of road, in base of fence post painted and scribed "U. S. B. M. 1285"; spike	1,284.87
Edison Electric Co.'s power tower 179, 3.7 miles east of, where road runs around top of west end of a long, narrow hill projecting westward, 25 feet west of center of road, in top of granite bowlder; aluminum tablet stamped "1495 B"	1,495.07
San Martinez Spring, 1.1 miles east of, on west side of road where it runs up ravine, in root of oak tree painted "U. S. B. M. 2495"; copper nail	2,495.30
Roland Hill's white shack, 0.4 mile southwest of, 50 feet west of road, in base of large oak tree painted "U. S. B. M. 2791"; spike	2,791.23
West Junction of Cummings Valley and Bear Valley roads, 395 feet south of, 15 feet south of road on granite bowlder painted "U. S. B. M. 2914"; chisel mark	2,913.64
West Junction of Cummings Valley and Bear Valley roads, 18 feet west of center of road; iron post stamped "2935 B"	2,934.125
West Junction of Cummings Valley and Bear Valley roads, 1 mile east of, where road crosses saddle, at north edge of road, in base of 12-inch oak tree painted and scribed "U. S. B. M. 3256"; spike	3,256.16
West junction of Cummings Valley and Bear Valley roads, 2.2 miles east of, at west edge of road, in base of 15-inch oak tree painted and scribed "U. S. B. M. 3102"; spike	3,101.82
West junction of Cummings Valley and Bear Valley roads, 3.1 miles east of, 25 feet north of road, in root of big oak tree painted and scribed "U. S. B. M. 3387"; copper nail	3,386.68
Jacks Camp, 35 feet north of road, at barn, in base of big oak tree painted and scribed "U. S. B. M. 3495"; spike	3,493.67
Jacks Camp, 1.2 miles east of, near top of steep grade, 10 feet south of edge of road, in top of granite bowlder; aluminum tablet stamped "3815 B"	3,813.924

[1] No adjustment has been made of this line, owing to an excessive closure error.

	Feet.
Cummings Valley, top of grade west from, where road crosses saddle, 40 feet west of road, in root of big oak tree painted and scribed "U. S. B. M. 4041"; copper nail	4,041.30
Cummings Valley School; 1 mile south of, at north edge of road, in base of southeast corner of well derrick painted and scribed "U. S. B. M. 3847"; spike	3,847.33
Cummings Valley School, in southeast corner of school lot; iron post stamped "3827 B"	3,825.667
Cummings Valley School, 1.5 miles north of by 1.5 miles east of, in southwest corner of crossroads, in base of telephone pole painted and scribed "U. S. B. M. 3904"; spike	3,904.13
Cummings Valley School, 3.5 miles northeast of, where road turns northeast before entering canyon, in northwest fence corner; iron post stamped "3953 B"	3,951.667
Dick Brite ranch, 0.8 mile west of, at north edge of road, in base of big oak stump painted and scribed "U. S. B. M. 4148"; copper nail	4,147.78
Dick Brite ranch, 1.4 miles east of, where road turns south, at southwest corner, in base of telephone pole painted and scribed "U. S. B. M. 4300"; spike	4,299.63
Tehachapi, 5 miles west of, at low place where road is crossed by drain, 105 feet west of gate, at north edge of road, in base of telephone pole painted and scribed "U. S. B. M. 4187"; spike	4,187.33
Tehachapi, 4.5 miles west of, where road turns north, in northwest fence corner; iron post stamped "4253 B"	4,251.908
Tehachapi, 2.4 miles west of, at top of rise, at south edge of road, in base of telephone pole painted and scribed "U. S. B. M. 4048"; spike	4,047.91
Tehachapi, 1.2 miles southwest of, at low place where road is crossed by drain, at north edge of road, in base of telephone pole painted and scribed "U. S. B. M. 3985"; spike	3,984.73

McKITTRICK QUADRANGLE.

Point 1.1 miles west of Buttonwillow southwest along highway and Southern Pacific Railroad to McKittrick.

Milepost 350, 340 feet west of, 50 feet east of private crossing, at north edge of right of way, in base of telephone pole painted and scribed "U. S. B. M. 262"; spike	262.02
Lokern, 0.5 mile east of, where road turns and crosses railroad, at north edge of road, on telephone line; iron post stamped "268 B"	267.697
Milepost 355, 435 feet south of, 150 feet north of point where highway crosses railroad, in base of telephone pole painted and scribed "U. S. B. M. 477"; spike	477.70
Milepost 356, 195 feet south of, in base of telephone pole scribed and painted "U. S. B. M. 555"; spike	555.74
McKittrick, 4.9 miles northeast of, 12 feet south of milepost 357; iron post stamped "641 B"	641.763
McKittrick, 3.9 miles northeast of, 180 feet south of milepost 358, in base of telephone pole painted and scribed "U. S. B. M. 731"; spike	731.22
McKittrick, 2.9 miles northeast of, at milepost 359, in base of telephone pole painted and scribed "U. S. B. M. 794"; spike	794.17
McKittrick, 1.9 miles northeast of, 180 feet south of milepost 360, in base of telephone pole painted and scribed "U. S. B. M. 891"; spike	891.26
McKittrick, 0.9 mile east of, 180 feet west of milepost 361, in base of telephone pole painted and scribed "U. S. B. M. 982"; spike	982.47

Point 11.8 miles southeast of McKittrick northwest 5.3 miles.

	Feet.
McKittrick, 9.7 miles southeast of, 100 feet west of road; iron post stamped "1197 B 1908 35 B"	1,196.869
McKittrick, 6.5 miles southeast of, east of road, 50 feet south of drain, 800 feet west of old derrick; iron post stamped "1275 B 1908 34 B"	1,275.053

Point near Job's ranch northwest to Simmler.

Job's ranch, about 1.5 miles northwest of, north of road, 150 feet north of wire fence, on small rock, painted "2750 B. M. 27"; chisel point	2,749.65
Job's ranch, 2.5 miles northwest of, on summit, 25 feet north of road, 200 feet northwest of junction of roads; iron post stamped "2871 B 1908 B B"	2,870.864
Job's ranch, 6.4 miles northwest of, north of road; point on small rock painted "2389 B. M. 30"	2,388.692
Job's ranch, 8.5 miles northwest of, 1,000 feet north of two small houses, 20 feet north of road; iron post stamped "2,239 B 1908 14 B"	2,238.729
Job's ranch, 10.6 miles northwest of, north of road; point on small rock painted "2097 B. M. 33"	2,097.20
Job's ranch, 13 miles northwest of, 100 feet west of windmill at sheep camp, 50 feet north of house; iron post stamped "2158 B 1908 15 B"	2,157.716
Kern County Land Co. ranch (R. Scott, foreman), 1 mile north of, west of road, in small rock; aluminum tablet stamped "2178 B 1908 16 B"	2,177.429
Kern County Land Co. ranch, 5.5 miles north of, 40 feet west of water tank; iron post stamped "1943 B 1908 17 B"	1,942.878
Kern County Land Co. ranch, 6.8 miles north of, north of road; point on small rock painted "1942 B. M. 37"	1,942.30
Miller & Lux cattle station, 2.3 miles southeast of, north of road; point on small rock painted "1935 B. M. 39"	1,934.73
Miller & Lux cattle station, 150 feet south of water tank, at fence corner; iron post stamped "1949 B 1908 18 B"	1,949.257
Carissa Chemical Co. soda works, 2.4 miles northwest of, north of road; point on small rock painted "1939 B. M. 43"	1,938.68
Hathaway Wells, at pump near fence; iron post stamped "1930 B 1908 19 B"	1,929.866
Simmler, 3.1 miles south of, east of road; point on small rock painted "1952 B. M. 48"	1,950.57
Simmler, 250 feet north of post office, 50 feet north of old flour mill, T. 30 S., R. 19 E., northwest corner; iron post stamped "2047 B 1908 20 B"	2,046.783

Point 12 miles southeast of McKittrick northwest to point 8.5 miles northwest of Fraziers Spring.

McKittrick, 3.5 miles southeast of, east of road, 5 feet north of telephone pole; iron post stamped "1410 B 1908 33 B"	1,409.43
McKittrick, southeast corner of schoolhouse lot; iron post stamped "1110 B 1908 32 B"	1,110.114
McKittrick, in front of station; top of east rail	1,050.4
McKittrick, 3.7 miles northwest of, south of road, 150 feet east of junction of roads, 150 feet west of pumping station, 15 feet south of road; iron post stamped "1244 B 1908 31 B"	1,243.756
Fraziers Spring, 1.8 miles northwest of, east of road, 10 feet north of junction; iron post stamped "910 B 1908 30 B"	909.567
Fraziers Spring, 4.8 miles northwest of, east of road, at junction of roads, 100 feet west of drain; iron post stamped "935 B 1908 29 B"	935.031
Fraziers Spring, 8.5 miles northwest of, 75 feet east of road, 500 feet north of canyon, at saddle, top of bowlder; aluminum tablet stamped "1333 B 1908 28 B"	1,332.271

HUASNA 30′ QUADRANGLE.

Simmler northwest to point 7.6 miles southwest of Somner's ranch.

	Feet.
Simmler, 4.7 miles northwest of, 20 feet west of well at fence corner; iron post stamped "2040 B 1908 21 B"	2,039.78
Simmler, 8.9 miles northwest of, southwest corner of sec. 35, T. 28 N., R. 17 E., 1 mile north of house with red roof; iron post stamped "2094 B 1908 22 B"	2,093.940

CHOLAME 30′ QUADRANGLE.

Point 7.6 miles southwest of Somner's ranch to Somner's ranch.

Somner's ranch, 4.3 miles southwest of, west of road, on summit between Simmler and Somner's ranch; iron post stamped "2347 B 1908 23 B"	2,347.018

Point 4.4 miles southeast of Orchard's well northwest via Dudley to Jones ranch.

Orchard's well, 1.2 miles southeast of, 2,000 feet north of derrick, at junction of roads; iron post stamped "652 B 1908 41 B"	651.248
Orchard's well, 1.4 miles northwest of, 3.8 miles southwest of Dudley, west of road, at junction; iron post stamped "613 B 1908 42 B"	612.850
Dudley, 1.5 miles south of, east of road, at junction; iron post stamped "655 B 1908 43 B"	655.039
Dudley, 0.4 mile north of, at crossroads, 5 feet north of section corner; iron post stamped "685 B 1908 44 B"	685.229
Dudley, 3.9 miles north of, east of road; iron post stamped "535 B 1908 45 B." (Reported to have been disturbed in letter from R. J. Reed, dated Oct. 24, 1910)	534.935
Dudley, 6.6 miles north of, east of road; iron post stamped "572 B 1908 B 46." (Reported to have been disturbed in letter from R. J. Reed, dated Oct. 24, 1910)	571.452
Anderson oil well, 1.8 miles southeast of, 0.5 mile north of cabin, at junction of roads, east of road; iron post stamped "666 B 1908 47 B"	665.108
Anderson oil well, 0.3 mile northwest of, south of road; iron post stamped "872 B 1908 48 B"	872.127
Jones ranch, 4.3 miles southeast of, 0.4 mile north of ranch house, west of road, 100 feet north of junction; iron post stamped "1171 B 1908 49 B"	1,170.607
Jones ranch, 1.6 miles southeast of, east of road; point on rock painted "1047 B. M. 109"	1,046.25

LOST HILLS 30′ QUADRANGLE.

Somner's ranch northeast to forks of road 0.5 mile northeast of Rock Corral.

Somner's ranch, 1,000 feet east of house, on east bank of wash, in top of bowlder, aluminum tablet stamped "1637 B 1908 24 B"	1,637.060
Somner's ranch, 3.5 miles northeast of, 20 feet west of wash, north of road, 100 feet north of wire fence, on rock painted "1350 B. M. 61;" chisel point	1,349.57
Somner's ranch, 8.2 miles northeast of, 0.5 mile west of Rock Corral, east of road, point on small rock painted "1005 B. M. 64"	1,008.581
Rock Corral, 0.5 mile east of, at junction of Coalinga-McKittrick road, 50 feet south of bank of wash; iron post stamped "949 B 1908 24 B"	948.969

Point 8.3 miles northwest of Braziers Spring northwest to forks of road 4.4 miles southeast of Orchard's well.

Rock Corral, 12.6 miles southeast of, east of road, 200 feet south of drain, on large bowlder, painted "1166 B. M. 70;" chisel point	1,166.14
Rock Corral, 11.3 miles southeast of, at road junction, 25 feet southeast of drain, east of road, iron post stamped "1175' B 1908 27 B'	1,174.803

	Feet.
Rock Corral, 6.8 miles southeast of, east of road, 50 feet east of junction; iron post stamped "1039 B 1908 26 B"	1,038.838
Rock Corral, 3.6 miles southeast of, southeast of east side of road, 2,000 feet southeast of small drain; iron post stamped "912 B 1908 25"	911.290
Rock Corral, 0.5 mile east of, at junction of Coalinga and McKittrick roads, 50 feet south of bank of wash; iron post stamped "949 B 1908 24 B"	948.969
Rock Corral, 4.02 miles northwest of, east of road; iron post stamped "706 B 1908 39 B"	706.863
Rock Corral, 8.1 miles northwest of, east of road, at junction of roads; iron post stamped "547 B 1908 40 B"	547.003

TEJON QUADRANGLE.

Point near southwest corner of sec. 4, T. 10 N., R. 19 W., south along highway to point 3.1 miles south of Rose station.

NOTE.—No adjustment has been made of this line, owing to an excessive closure error.

T. 10 N., R. 19 W., near northwest corner of sec. 4, 20 feet west of center of road, just south of point where cut-off road to Bakersfield turns west near telephone pole 1368; iron post stamped "1085 LA"	1,086.919
Rose, 0.7 mile north of, west side of road where telephone line turns east in base of telephone pole 1408, painted "U. S. B. M. 1199;" spike	1,199.09
Rose, 0.7 mile south of power tower 300, on west lower brace, marked "U. S. □ B. M.;" chisel mark	1,367.16
Rose, 1.5 miles south of, power tower 308, on south lower brace, marked "U. S. □ B. M.;" chisel mark	1,535.03

Fresno, Mariposa, and Merced 30′ quadrangles.

FRESNO, MADERA, MARIPOSA, AND MERCED COUNTIES.

The elevations in the following list are based on the results of precise leveling along the Southern Pacific Railroad, published in bulletin 342.

Leveling was done in the Fresno quadrangle in 1901, 1902, and 1903, by L. D. Ryus, in the Merced quadrangle in 1905 by C. H. Semper, and in the Fresno, Mariposa, and Merced quadrangles in 1908 by L. F. Biggs. The work of 1908 was done in cooperation with the State; previous leveling was not cooperative.

FRESNO QUADRANGLE.

Fresno east along stage road to Kingriver post office.

	Feet.
Fresno, Southern Pacific Railroad passenger station; aluminum tablet	289.983
Fresno, 3 miles east of station, 400 feet west of crossing of Sunnyside car line and Ventura Avenue, 1 mile east of Fresno schoolhouse, at south edge of road; iron post	304.849
Fresno, 6 miles east of, northeast corner of Sunnyside vineyard, north side of Centerville road, west side of Fowler road, at intersection; iron post stamped "323 B"	323.024
Fresno, 9 miles east of, on south edge of Centerville road, 40 feet east of section line, opposite square yellow house; iron post	348.49
Centerville, 4 miles west of, 50 feet west of corner of section, at road crossing, between wheat ranches, south edge of road; iron post	372.77
Centerville (Kingriver postoffice), 1 mile west of, 0.25 mile east of Fowler ditch, south edge of county road; iron post	393.35

Fresno along Southern Pacific Railroad east to Las Palmas, thence north via Clovis to Pollasky, thence along highway west to closure on precise-level line at Madera (adjusted with Biggs's 1908 running).

	Feet.
Barton, 1.2 miles east of, in southeast corner of vineyard, north of schoolhouse, east of wagon road, south of track; iron post	316.64
Tarpy, 150 feet north of station platform, at southwest corner of NW. ¼ section 20, T. 13 S., R. 21 E., on ditch bank west of track; iron post	347.200
Clovis, west edge of railroad right of way, 75 feet south of first switch block south of planing mill; iron post	355.690
Gordon, 150 feet north of south end of switch, at west edge of railroad right of way; iron post stamped "391"	390.650
Pollasky, 450 feet south of station, opposite milepost 231, at east edge of railroad right of way; iron post stamped "337"	339.135
Pollasky, 6.25 miles west of, 75 feet north of corner of small pasture at rocky point, south side of road; iron post stamped "451"	451.355
Cottonwood schoolhouse, 0.5 mile north of, north side of road, against fence of adobe ranch; iron post stamped "342"	342.288
Madera, 4 miles east of, 200 feet east of first small hill south of Sugar Pine and Madera road, 20 feet south of lumber flume, at north side of public road; iron post stamped "304"	304.347

Clovis northeast along road to point near Letcher.

Clovis, 3 miles northeast of, 50 feet north of flume section house 7, east side of road; iron post	408.650
Collins ranch, 1.1 miles east of, southwest of section house 6, south side of road, opposite curve in flume; iron post	460.349
Letcher, 0.5 mile north of, in granite rock in pasture, 50 feet east of county road; aluminum tablet stamped "601 F"	596.691

MARIPOSA 30′ QUADRANGLE.

Point near Ahwahnee southeast along road to point 2 miles southeast of North Fork post office.

Ahwahnee, 1.2 miles east of, 200 feet north of junction of Fresno Flats and Raymond road, 30 feet west of road, in bowlder; aluminum tablet stamped "2323 B 1908 B. K."	2,320.205
Ahwahnee, 2.2 miles southeast of, 15 feet west of road, at second-class road junction, in base of 30-inch pine tree; spike with aluminum tag stamped "2130 B. M. 38"	2,127.43
Fresno Flats, 2.7 miles west of, north of road, opposite ranch house, in base of 48-inch oak tree; spike with aluminum tag stamped "2209 B. M. 40"	2,206.90
Fresno Flats, 1.4 miles west of, 25 feet south of road, 300 feet south of ranch house, 500 feet east of bridge over small creek, in base of 48-inch oak tree; spike with aluminum tag stamped "2347 B. M. 41"	2,344.50
Fresno Flats, sec. 14, T. 7 S., R. 21 E., 50 feet east of China Creek, at fence in granite bowlder; aluminum tablet stamped "2271 B 1908 B. L."	2,268.558
Fresno Flats, 1.2 miles east of, south of road, north one of two pine trees, in base of 48-inch tree; spike with aluminum tag stamped "2599 B. M. 43"	2,596.34
Fresno Flats, 3.8 miles east of, north of road, 1.5 miles west of summit of ridge, between Fresno Flats and Crane Valley, on granite bowlder painted "3247 B. M. 46"; chisel point	3,248.12
Fresno Flats, 4.3 miles southeast of, 10 feet west of road, at road junction, 1 mile west of summit of ridge between Fresno Flats and Crane Valley, in granite bowlder; aluminum tablet stamped "3508 B 1908 B. M."	3,504.448

	Feet.
Fresno Flats, 8.3 miles east of, 7 miles west of North Fork, 100 feet northeast of road, 150 feet south of creek, in base of 48-inch pine tree; spike with aluminum tag stamped "3324 B. M. 49"	3,321.69
North Fork, 6.7 miles northwest of, 100 feet north of road, 250 feet west of barn at San Joaquin Light & Power Co. dam 1, in bowlder; aluminum tablet stamped "3317 B 1908 B. N."	3,316.658
North Fork, 5.9 miles west of, 150 feet south of south end of San Joaquin Light & Power Co. flume 4, on bridge over ditch, on concrete cap painted "3253"; chisel point	3,250.59
North Fork, 4.3 miles northwest of, 200 feet west of flume, 50 feet north of road, in base of 48-inch pine tree; spike with aluminum tag stamped "3210 B. M. 52"	3,207.19
North Fork, 2.5 miles northwest of, northeast corner of San Joaquin Light & Power Co. power house, in foundation; aluminum tablet stamped "2827 B 1908 B. O."	2,824.671
North Fork, 1.7 miles northeast of, at headquarters of Sierra National Forest, 250 feet southeast of office, in base of 40-inch oak tree; spike with aluminum tag stamped "2951 B. M. 53"	2,948.69
North Fork, 500 feet northeast of post office, on Sierra National Forest line, corner of saloon, in granite bowlder; aluminum tablet stamped "2642 B 1908 B. P."	2,638.877

Point 1.2 miles southeast of North Fork post office southwest to Pollasky.

North Fork, 2.8 miles southwest of, south of road, 25 feet west of road junction, in base of 30-inch oak tree; spike with aluminum tag stamped "2894 B. M. 57"	2,891.26
North Fork, 5.4 miles southwest of, north of road, at junction of Crane Valley-North Fork roads, in base of 36-inch oak tree; spike with aluminum tag stamped "2653 B. M. 60"	2,650.03
North Fork, 6 miles southwest of, west edge of road, 3.4 miles southeast of Cleveland District schoolhouse, 600 feet east of ranch house, in granite bowlder; aluminum tablet stamped "2586 B 1908 B. Q."	2,583.10
North Fork, 8.2 miles southwest of, west of road, 1,000 feet north of ranch house, in fence corner, in base of 36-inch oak tree; spike with aluminum tag stamped "1955 B. M. 62"	1,951.97
Oneals, 6.3 miles northeast of, 25 feet west of road, 200 feet west of Mountain View schoolhouse, in granite bowlder; aluminum tablet stamped "1305 B 1908 B. R."	1,301.506
Oneals, 3.9 miles northeast of, at central station, 100 feet south of house, in base of 36-inch pine tree; spike with aluminum tag stamped "1250 B. M. 66"	1,246.75
Oneals, 2.8 miles northeast of, west of road, 100 feet west of junction of road, in base of 24-inch oak tree; spike with aluminum tag stamped "1387 B. M. 67"	1,383.52
Oneals, 0.5 mile west of, 200 feet north of Oneals ranch house, at intersection of roads, in granite bowlder; aluminum tablet stamped "1246 B 1908 B. S."	1,242.822
Oneals, 2.8 miles southwest of, on summit of Cop Hill, on granite bowlder painted "1336 B. M. 71;" chisel point	1,332.70
Oneals, 5.8 miles southwest of, 6 miles north of Pollasky, 150 feet southeast of intersection of Pollasky and Madera roads, in granite bowlder; aluminum tablet stamped "611 B 1908 B. T."	608.175

	Feet.
Pollasky, 3 miles north of, 100 feet southeast of pump, 30 feet south of road, in base of 36-inch cottonwood tree; spike with aluminum tag stamped "418 B. M. 76"	414.58
Pollasky, northeast corner of bridge over San Joaquin River, on concrete guard, 5 feet from fence corner; aluminum tablet stamped "U"	330.014
Pollasky, 450 feet south of station, opposite milepost 231, at east edge of right of way of railroad; iron post stamped "337"	339.135
Daulton southeast to point 6 miles west of Pollasky, thence to point 2.3 miles north of Pollasky.	
Daulton, 150 feet north of station, west edge of railroad right of way, 10 feet south of gate, at fence line; iron post stamped "400 B 1908 B. X."	400.140
Daulton, 3.1 miles southeast of, west of road, at gate to Daulton ranch, on main road between Raymond and Berenda, 15 feet north of gate, on fence line; iron post stamped "561 B 1909 B. E. 1"	561.095
Daulton, 7 miles southeast of, 300 feet south of head of irrigation ditch, 60 feet west of Fresno River, 200 feet north of ford, in granite bowlder; aluminum tablet stamped "386 B 1909 B. F. 1"	386.748
Fresno River ford at Adobe ranch, 1.8 miles southeast of, 0.7 mile north of red house, 60 feet north of second-class road, northwest of triangulation station, on bowlder painted "419 B. M. 110;" chisel point	419.01
Fresno River ford at Adobe ranch, 9.7 miles southeast of, 350 feet northwest of triangulation station, 10 feet south of gate to field on second-class road, 0.5 mile west of large barn; iron post stamped "471 B 1909 B. G. 1".	470.601
Fresno River ford at Adobe ranch, 12 miles southeast of, 1 mile east of Adobe triangulation station, 25 feet west of creek at old house, on bowlder painted "446 B. M. 112"; chisel point	445.70
Pollasky, 6.2 miles west of, 75 feet north of corner of small pasture, at rocky point south of road; iron post stamped "451"	451.355
Pollasky, 6 miles west of, 150 feet south of fence corner at intersection of roads, driven in crack in granite bowlder painted "466 B. M. 80"; spike.	467.92
Pollasky, 4.9 miles west of, 20 feet east of road in base of fence post painted "535 B. M. 17"; spike (redetermined Ryus bench mark.)	534.98
Pollasky, 4.4 miles west of, 500 feet west of schoolhouse, 5 feet south of road, on granite bowlder painted "503 B. M. 79"; chisel point	505.56
Pollasky, northeast corner of bridge over San Joaquin River, on concrete guard, 5 feet from fence corner; aluminum tablet stamped "U"	330.014
Daulton northeast along railroad and highway to Ahwahnee.	
Daulton, in front of station; top of rail	400.5
Daulton, 150 feet north of station, west edge of railroad right of way, 10 feet south of gate, at fence line; iron post stamped "400 B 1909 B. X."	400.140
Jesbel station, 25 feet south of milepost 192, west edge of railroad right of way; iron post stamped "527 B 1909 B. Y."	526.972
Raymond, 2.7 miles south of, at railroad crossing, west margin of road, in granite bowlder; aluminum tablet stamped "864 B 1909 B. Z."	863.812
Raymond, in front of station; top of rail	925.3
Raymond, 20 feet south of Raymond livery stable, opposite station, west margin of road, in granite bowlder; aluminum tablet stamped "936 B 1909 B. A. 1"	937.182
Raymond, 1.2 miles north of, west side of road, in base of 24-inch oak tree; spike; with aluminum tag stamped "1053 B. M. 91"	1,053.722
Raymond, 1.9 miles north of, at intersection of road to Fresno Flats, 200 feet south of house, spike in base of 30-inch oak tree with aluminum tag stamped "1263 B. M. 92"	1,264.090

	Feet.
Raymond, 2.7 miles north of, at intersection of roads, at rocky point, on granite bowlder painted "1257 B. M. 93"; chisel point	1,258.17
Raymond, 5 miles north of, at small draw, 2.7 miles south of Summit House, east of road, in granite bowlder; aluminum tablet stamped "1356 B 1909 B. B. 1"	1,355.672
Raymond, 6 miles north of, 1.6 miles south of Summit House, 25 feet east of road, in base of 30-inch oak tree; spike with aluminum tag stamped "1632 B. M. 95"	1,632.21
Raymond, 8 miles north of, 0.3 mile north of Summit House, west edge of road, on summit of ridge, in granite bowlder; aluminum tablet stamped "2042 B 1909 B. C. 1"	2,041.841
Grub Gulch, 2.7 miles south of, on summit of ridge, east edge of road, in base of 20-inch oak tree; spike with aluminum tag stamped "1992 B. M. 99"	1,992.07
Grub Gulch, 1.3 miles south of, west side of road, 50 feet west of fence corner, in base of 36-inch pine tree; spike with aluminum tag stamped "2154 B. M. 100"	2,153.85
Grub Gulch, 0.3 mile north of, on summit of ridge between Grub Gulch and Ahwahnee, south side of road, 2,000 feet south of old McCloud ranch, at bend in road, in granite bowlder; aluminum tablet stamped "2495 B 1909 B. D. 1"	2,494.717
Grub Gulch, 1.7 miles north of, 300 feet west of old house, at bend of road, 150 feet south of draw, in base of 36-inch oak tree; spike with aluminum tag stamped "2257 B. M. 102"	2,256.612
Grub Gulch, 3.9 miles north of, 50 feet west of road, at junction of Poisior Switch and Ahwahnee roads, on granite bowlder painted "1943 B. M. 104;" chisel point	1,942.823

Mount Bullion schoolhouse east along road to Ahwahnee.[1]

Mount Bullion, 200 feet east of schoolhouse, 30 feet north of road; iron post stamped "2177 B 1908 B. E."	2,175.256
Mount Bullion, 2.4 miles east of, north side of road, in base of 36-inch pine tree; spike with aluminum tag stamped "2332 B. M. 17"	2,330.18
Mariposa, 0.7 mile west of, 400 feet west of cemetery, 20 feet south of road, on bowlder painted "2049 B. M. 20;" chisel point	2,046.39
Mariposa, courthouse, southeast corner of Hall of Records, 4 feet above ground; aluminum tablet stamped "2022 B 1908 B. F."	2,018.967
Mariposa, 2.2 miles east of, 300 feet west of Mormon Bar Hotel, south of road, on bowlder painted "1767 B. M. 22;" chisel point	1,765.27
Mormon Bar, 2.3 miles east of, 1.5 miles west of Bootjack, 40 feet north of road, 300 feet west of summit of hill, in bowlder; aluminum tablet stamped "2456 B 1908 B. G."	2,453.936
Bootjack, 0.2 mile east of, at intersection of Yosemite and Hites Cove roads, in base of 48-inch oak tree; spike with aluminum tag stamped "2244 B. M. 25"	2,241.97
Bootjack, 2.6 miles east of, 150 feet north of road junction, at Thompson ranch, 10 feet west of road, in large bowlder; aluminum tablet stamped "2232 B 1908 B. H."	2,228.114
Bootjack, 4.6 miles east of, 60 feet west of road, on summit of ridge between Bootjack and Chowchilla, on large bowlder painted "2976 B. M. 28;" chisel point	2,973.67

[1] The error of closure between Merced Falls via Bullion to Ahwahnee was 3.556 feet, but as the portion between Mount Bullion and Ahwahnee was retraced by secondary levels this part has been adjusted, leaving an outstanding error west of Bullion of 3.227 feet to be located later. See the Merced quadrangle list.

	Feet.
Bootjack, 6.1 miles east of, 0.9 mile west of Chowchilla schoolhouse south of road at ranch house, east bank of creek, in base of 40-inch pine tree; spike with aluminum tag stamped "2820 B. M. 30"	2,817.48
Chowchilla schoolhouse, 0.3 mile east of, 50 feet south of intersection of Wawona and Warwane roads, 100 feet north of barn, in bowlder; aluminum tablet stamped "2963 B 1908 B. L."	2,960.532
Chowchilla schoolhouse, 2.4 miles east of, 1.5 miles west of Grants Springs, 50 feet east of Chowchilla Creek, opposite ranch house, in base of 36-inch oak tree; spike with aluminum tag stamped "2296 B. M. 32"	2,293.12
Grants Springs, midway between spring house and old house, in base of 30-inch cedar tree; spike with aluminum tag stamped "2872 B. M. 33"	2,868.89
Ahwahnee, 3.1 miles west of, 150 feet west of road, on summit between Grants Springs and Ahwahnee, in bowlder; aluminum tablet stamped "3336 B 1908 B. J."	3,333.346
Ahwahnee, 1.9 miles west of, at junction of road to Summerdale and Miami sawmill and Raymond road, in base of 36-inch oak tree; spike with aluminum tag stamped "2928 B. M. 35"	2,926.03
Ahwahnee, 1.2 miles west of, west side of road, at junction of second-class road, on bowlder painted "2800 B. M. 36;" chisel point	2,797.92
Ahwahnee, 1.2 miles east of, 200 feet north of junction of Fresno Flats and Raymond road, 30 feet west of road, in bowlder; aluminum tablet stamped "2323 B 1908 B. K." (Junction bench mark)	2,320.205

MERCED 30′ QUADRANGLE.

Merced north along highway to Merced River.

Merced, southeast corner of county courthouse; aluminum tablet stamped "171 B"	171.118
Merced, 4.3 miles north of, at entrance to Crocker Huffman back ranch, west of road, 20 feet north of gate; iron post stamped "175 B"	175.222
Sixmile House, northeast corner of fork with road to east; iron post stamped "206 B"	205.775
Sixmile House, 3.3 miles north of, 65 feet south of bridge over creek, east of road; iron post stamped "377 B"	376.949
Sixmile House, 6.7 miles north of, at northwest corner of fork with road to west; iron post stamped "284 B"	283.913

Amsterdam southeast along railroad to Merced.

Amsterdam, 3.3 miles southeast of, north margin of railroad and highway, 4 feet east of milepost 157; iron post stamped "196 B"	195.984
Amsterdam, 5.4 miles southeast of, at southwest corner of fork with road to Atwater, at J. J. Gray's ranch house; iron post stamped "175 B"	175.333

Berenda northeast along Southern Pacific Railway to Daulton.

Berenda, 3 miles north of, 200 feet north of Atchison, Topeka & Santa Fe Railway crossing, west edge of Southern Pacific Railroad right of way, 10 feet south of milepost 181; iron post stamped "279 B 1909 B. V."	278.711
Talbot, in front of station; top of rail	332,8
Talbot, 800 feet north of station, west edge of railroad right of way, at road crossing; iron post stamped "331 B 1909 B. W."	331.187
Daulton, in front of station; top of rail	400.6

Merced Falls via Hornitos to Mount Bullion schoolhouse.[1]

Merced Falls, at northeast corner of yard of Merced Falls Power Co., on margin of road; iron post stamped "351 B"	351.125

[1] Unadjusted line closing 3.227 feet high at Mount Bullion schoolhouse.

	Feet.
Merced Falls, south corner of bridge over Merced River; top of bolt over pier painted "350 B.M. 1"	349.335
Merced Falls, 1.7 miles east of, 100 feet south of road, on summit of small hill, in base of oak tree 20 inches in diameter; spike with aluminum tag stamped "499 B.M. 2"	499.405
Merced Falls, 3.2 miles east of, 15 feet south of road, 0.04 mile south of ranch house, in base of oak tree 24 inches in diameter; spike with aluminum tag stamped "745 B.M. 3"	745.170
Merced Falls, 4.9 miles east of, 1,000 feet west of road junction, 20 feet south of road; chisel-point on bowlder painted "910 B.M. 4"	910.149
Merced Falls, 5.5 miles east of, 1 mile south of Hornitos, 15 feet east of road, near sharp turn in road, 25 feet north of oak tree, in bowlder; aluminum tag stamped "829 B 1908 B.A."	829.791
Hornitos, 0.9 mile east of, north side of road, at east end of olive orchard, in base of oak tree 24 inches in diameter; spike with aluminum tag stamped "871 B.M. 6"	872.410
Hornitos, 2.2 miles east of, south side of road, west bank of drain, in base of oak tree 20 inches in diameter; spike with aluminum tag stamped "980 B.M. 7"	981.292
Hornitos, 3.2 miles east of, 0.5 mile west of, at Ruth Pierce mine, north side of road, on summit of small ridge, in bowlder; aluminum tablet stamped "1094 B 1908 B. 13"	1,094.649
Hornitos, 4 miles east of, southwest corner of intersection of road to Indian Gulch, 1,000 feet east of Ruth Pierce mine, in base of fence post; spike with aluminum tag stamped "1144 B.M. 8"	1,145.183
Hornitos, 4.7 miles east of, 2 miles east of Ruth Pierce mine, 500 feet south of house, 250 feet east of drain at bend of road, on bowlder painted "1153 B.M. 9"; chisel point	1,154.244
Hornitos, 6.4 miles east of, north side of road, 0.4 mile west of Molony ranch house, on west line of Merced grant at junction of Cathray Valley and Mariposa road, on bowlder; aluminum tablet stamped "1160 B 1908 B. C."	1,161.560
Mount Bullion, 6 miles west of, 6.9 miles east of Hornitos, north side of road, north bank of canyon, in bowlder painted "1434 B. M. 10"; chisel point.	1,435.210
Mount Bullion, 5.3 miles west of, east side of road, on summit of rise, at ruin of old house, in base of oak tree 20 inches in diameter; spike with aluminum tag stamped "1702 B.M. 11"	1,703.481
Mount Bullion, 4.2 miles west of, on summit of ridge, 25 feet south of road, in bowlder; aluminum tablet stamped "1828 B 1908 B.D."	1,828.865
Mount Bullion, 3.5 miles west of, 60 feet northeast of creek, 150 feet east of water trough, north side of road, on rock painted "1680 B.M. 12"; chisel point	1,680.944
Mount Bullion, 2.5 miles west of, 50 feet west of old house, north side of road, on bowlder painted "1837 B.M. 13"; chisel point	1,838.122
Mount Bullion, 1.2 miles west of, east side of road, opposite mine, west bank of creek, in base of oak tree 20 inches in diameter; spike with aluminum tag stamped "1964 B.M. 14"	1,965.121
Mount Bullion, 0.5 mile west of north side of road, on summit of hill, in base of pine tree 24 inches in diameter; spike with aluminum tag stamped "2217 B.M. 15"	2,217.746
Mount Bullion, 200 feet east of schoolhouse, 30 feet north of road; iron post stamped "2177 B 1908 B.E."	2,178.483

Bridgeport, Hawthorne, and Mount Lyell quadrangles.

MONO AND TUOLUMNE COUNTIES.

The elevations in the following list are based on a bench mark at Bridgeport, of which the elevation now adopted is 4 feet greater than that given in Bulletin 342. This correction was determined by leveling between Hawthorne, Nev., and Mohave, Cal., and allows for orthometric error from Mohave and a small correction at Mohave.

The leveling was done by C. M. Weston in 1909 and C. R. Smith in 1898, without State cooperation.

BRIDGEPORT QUADRANGLE.

Bodie via stage road to Bridgeport, thence northwest via stage road to State line.

	Feet.
Bodie, 1.1 miles east of, 50 feet east of first dam above stamp mill, 10 feet south of road, on bowlder painted "8303;" chiseled square	8,301.67
Bodie, northwest corner of Main and Green streets, 3 feet from hydrant, between two large wooden posts; iron post stamped "8375"	8,373.881
Bodie, 1.2 miles northwest of, about 1,000 feet southeast of summit in road, on east side of road, on bowlder painted "8462;" chiseled square	8,460.35
Bodie, 2.2 miles northwest of, 200 feet west of bend in road around point, on bowlder on southwest side of road, painted "8326;" chiseled square	8,324.93
Bodie, 3.5 miles northwest of, at Murphy Springs, on east side of road, 10 feet east of watering tub; iron post stamped "8112"	8,110.549
Bodie, 4.7 miles northwest of, east of summit in road, 10 feet north of road, on bowlder painted "8131;" chiseled circle	8,129.24
Bodie, 6.1 miles northwest of, 30 feet south of north junction of old and new roads, 10 feet southwest of center of old road, on bowlder painted "8065;" chiseled square	8,063.78
Bodie, 7.5 miles northwest of, 100 feet south of crossing of old and new roads, 15 feet west of new road, on bowlder painted "7716;" chiseled square	7,714.90
Bodie, 8.7 miles northwest of, at old Mormon ranch, 2 feet from northwest corner of barn, on south side of road; iron post stamped "7425"	7,423.682
Bodie, 10 miles northwest of, 100 feet west of top of small rise in road, north of green pasture, on south side of road, on bowlder painted "7271;" chiseled square	7,269.64
Clearwater Creek crossing, 20 feet north of bridge; iron post stamped "7196 O"	7,205.250
Bodie, 10.4 miles northwest of, north of road, opposite creek in canyon, 3 feet above road, around point on ledge; chiseled circle painted "7141".	7,139.79
Bodie, 12 miles northwest of, 8 feet south of road, between road and Clearwater Creek in deep canyon, in large 25-foot bowlder; aluminum tablet stamped "6935"	6,933.724
Bodie, 13 miles northwest of, 40 feet east of junction of Green and Clearwater creeks, 15 feet west of turn in road, on bowlder painted "6835;" chiseled square	6,833.81
Bridgeport, 6 miles south of, 300 feet north of high point of ledge east of road, 12 feet west of road, on bowlder painted "6723;" chiseled square.	6,722.00
Tollgate, Bridgeport-Bodie road, near northeast corner of house; iron post stamped "6643 O"	6,651.705
Bridgeport, 2.7 miles south of, on south slope of low ridge, 15 feet west of road, on low ledge painted "6505;" chiseled square	6,503.90

	Feet.
Bridgeport, 1 mile south of, 175 feet west of culvert, in base of telephone pole painted "6471," first pole south of pasture gate on west side of road; spike	6,469.13
Bridgeport, at southwest corner of courthouse; iron post stamped "6465 O"	6,473.436
Bridgeport, 2.4 miles east of, 150 feet east of corner of pasture fence on north side of road, 5 feet north of fence and on edge of dry channel, on bowlder painted "6448;" chiseled square	6,446.25
Bridgeport, 2.9 miles east of, at Stewart's ranch, 3 feet south of corner fence post at west turn from main road; iron post stamped "6449"	6,447.686
Bridgeport, 3.8 miles northeast of, 70 feet north of dry channel, 25 feet west of road, on bowlder painted "6465;" chiseled square	6,464.05
Bridgeport, 5 miles northeast of, 200 feet east of river and 15 feet west of road, on bowlder 1 foot high, painted "6431;" chiseled square	6,429.25
Bridgeport, 5.9 miles northeast of, about 900 feet east of old ranch, in field on north side of road and 10 feet north of fence on large bowlder painted "6416;" chiseled square	6,414.42
Bridgeport, 6.7 miles northeast of, 400 feet southwest of bridge over East Walker River and 25 feet east of road, at foot of high cliff, in large bowlder; aluminum tablet stamped "6398"	6,396.466
Bridgeport, 7.5 miles northeast of, 5 feet north of road and about 50 feet north of river, on bowlder painted "6362;" chiseled square	6,353.36
Bridgeport, 8.6 miles northeast of, 25 feet west of and 4 feet above river, 75 feet south of long narrow island, 12 feet east of road, on bowlder painted "6312;" chiseled square	6,310.20
Bridgeport, 10.2 miles northeast of, 55 feet west of road and 130 feet west of river, on east side of high bluff, in granite ledge; aluminum tablet stamped "6202"	6,200.721
Bridgeport, 11 miles northeast of, on east side of road, 75 feet west of river and 3 feet east of wire fence, on bowlder 4 feet high, painted "6132"; chiseled square	6,130.82
Bridgeport, 12.3 miles northeast of, 1,000 feet south of Sam Philatro's ranch, 15 feet east of road, on small rise, on bowlder painted "6066"; chiseled square	6,064.17
Bridgeport, 13.1 miles northeast of, 0.6 mile northeast of Sam Philatro's ranch, on west side of road, opposite stone embankment, on bowlder painted "6011;" chiseled square	6,009.11
Bridgeport, 13.7 miles northeast of, on California-Nevada State line, survey of 1873, 25 feet west of road; iron post stamped "5966"	5,954.665

Point 2.5 miles west of Blackburn's ranch to Bridgeport.

Hardy (Blackburn's ranch), about 2.5 miles west of, on rock ledge 1,400 feet east of bridge over West Walker River, in a bend of the road, on south side of grade; copper bolt stamped "6703" (elevation by corrected line from Stockton, 6,702.518)	6,710.247
Hardy (Blackburn's ranch), at junction of Sonora-Mono toll road and Carson Road, 60 feet east of Little Walker River; iron post stamped "6942"	6,949.779
Summit between Blackburn's ranch and Bridgeport, 15 feet east of road; iron post stamped "7540 O"	7,548.776
Hunttoon station, on right side of road, 100 feet below water trough; iron post stamped "6837 O"	6,845.978
Bridgeport, 3 miles northwest of, east side of road, at north side of Sinnimon's Lane; iron post stamped "6496 O"	6,504.547

Point 10 miles southeast of Bridgeport via State road to Mono Lake.

	Feet.
Bridgeport, 10 miles southeast of, at sheep camp, 50 feet above water trough across road; iron post stamped "7350 O"	7,358.769
Hector's station, on Bodie-Lundy road, across road from dwelling house at edge of orchard and garden; iron post stamped "6760 O"	6,769.285
Jordan Creek crossing of Bodie-Lundy road, 150 feet south of bridge, on north side of road; iron post stamped "6779 O"	6,787.387
Mono, 4 feet east of southwest corner of sec. 19, T. 2 N., R. 26 E., about midway between post office and schoolhouse, on hillside, about 350 feet in elevation above lake and about 2,000 feet in horizontal distance from lake shore; iron post stamped "6761 O"; witnessed by mound of rocks	6,769.711
Mono Lake, surface of water, July 27, 1898	6,421.3
Mono Lake, surface of water, October, 1909	6,426

HAWTHORNE QUADRANGLE.

State line on Hawthorne-Bodie road to Bodie.

Fletcher, 8.1 miles southwest of, on California-Nevada State line, survey of 1873, 25 feet south of milepost 283, 300 feet east of old stone house, at Sunshine, 15 feet north of road; iron post stamped "7524"	7,522.624
Fletcher, 10.3 miles southwest of, at Gregory's ranch, southwest of house, 20 feet east of road, on ledge, painted "7821;" chiseled square	7,819.62
Fletcher, 10.9 miles southwest of, opposite old stamp mill, in face of high ledge on south side of road, 20 feet north of northwest corner of ledge; aluminum tablet stamped "7908"	7,906.451
Bodie, 4 miles northeast of, 6 feet east of road, between Bodie Creek and road, 3 feet north of telephone pole, on bowlder painted "8018;" chiseled square	8,016.45
Bodie, 2.7 miles east of, in front wall of H. C. Blanchard's stone house at tollgate, 6 feet west of southeast corner of house; aluminum tablet stamped "8133"	8,131.444

MOUNT LYELL QUADRANGLE.

Mono post office southeast to Rush Creek.

Ney's ranch, sec. 4, T. 1 N., R. 26 E., near Mono Lake shore, in large bowlder on north side of road and 200 feet east of blacksmith shop; aluminum tablet stamped "6423 O"	6,431.471
T. 1 N., R. 26 E., sec 13, Rush Creek crossing, junction of lake road with Rush Creek road from Farrington station; iron post stamped "6442 O"	6,450.571

Ney's ranch (shore of Lake Mono) south along road to junction of road in sec. 9, T. 2 S., R. 27 E.

T. 1 N., R. 26 E., northeast corner of sec. 33, Farrington station, 50 feet south of dwelling, inside fence at edge of road Walter Lake; iron post stamped "6854 O"	6,862.729
T. 1 S., R. 27 E., sec. 29, Owens River road, 7 miles southeast of Farrington station, at head of short, steep grade, at upper edge of grove of trees, 10 feet left of road; iron post stamped "7601 O" (elevation brought from Mohave, 7,612.182)	7,609.827
T. 2 S., R. 27 E., sec. 9, Long Valley and Owens River road, at junction of with Bodie and Benton wagon road, on north side of road; iron post stamped "7938 O" (elevation brought from Mohave, 7,948.998)	7,946.643

Farrington south to Silver Lake.

Grant Lake, at outlet, 10 feet east of road; iron post stamped "7068 O"	7,077.228
Silver Lake, at outlet; iron post stamped "7217 O"	7,225.937

Ney's ranch up Leevining Creek road to Sec. 23, T. 1 N., R. 26 E.

	Feet.
T. 1 N., R. 26 E., quarter corner between secs. 23 and 24; iron post stamped "7467 O"	7,476.097

Farrington southwest along road and trail to Mono Pass, thence west along trail to Snow Flat.

Walker Lake, 100 feet north of outlet, at upper end of wagon road where Bloody Canyon trail begins, near dwelling of A. Grose, 100 feet from lake and 123 feet from fence; iron post stamped "7929 O"	7,938.030
Walker Lake; surface of water, September 1, 1898	7,935.6
Sardine Lake; surface of water, September 26, 1898	9,885.1
Mono Pass, 30 feet north from shore of Summit Lake and 4 feet to right of trail; iron post stamped "10599 O"	10,607.604
Dana Fork, trail at point where sheep trail branches to right through timber alongside hill and where stream turns west to main trail, continuing northwest down to meadows, in rock at southwest corner of cabin; aluminum plug stamped "U. S. G. S. 9738 Ft. B. M. O."	9,746.563
Soda Springs, 3.5 miles east of, on north side of Tioga road where trail comes in from the meadows to the eastward of road, in outcropping ledge of rock; aluminum bolt stamped "U. S. G. S. 9270 Ft. B. M. O."	9,278.794
Soda Springs, 100 feet west of, in large granite bowlder on south side of trail; aluminum bolt stamped "U. S. G. S. 8594 Ft. B. M. O."	8,602.681
T. 1 S., R. 23 E., southeast corner of sec. 1, Diablo meridan; iron post stamped "8555 O"	8,564.118
Cathedral Creek, in conspicuous rock in north side of creek bed, 50 feet from road; aluminum bolt stamped "U. S. G. S. 8337 Ft. B. M. O."	8,346.076
Lake Tanaya, on west shore of, in large bowlder between road and lake shore about 300 feet east of three log cabins in grove of trees; aluminum tablet stamped "U. S. G. S. 8146 Ft. B. M. O."	8,154.447
Lake Tanaya; surface of water, September 17, 1898	8,150
Snow Flat, 300 feet southwest of wooden culvert in road crossing, in large granite bowlder, on west side of road; aluminum tablet stamped "U. S. G. S. 8705 Ft. B. M. O." (recovered in 1905 by leveling from Merced, and correction made)	8,714.341

Dana Fork trail north to Tioga.

Tioga Pass summit, on rock on east side of road; aluminum tablet stamped "9941 Ft. B. M. O."	9,950.188
Tioga mine, in ledge of rock, at southwest corner of assay office; round iron plug set in cement and marked "9795"	9,803.745

At Miller Bridge.[1]

Miller Bridge, sec. 11, T. 5 S., R. 25 E., 15 feet east of bridge over Middle Fork of San Joaquin River, in granite ledge; bronze tablet stamped "4556 F"	4,567.252

Crucero and Ivanpah 1° quadrangles.

SAN BERNARDINO COUNTY.

The elevations in the following list are based on an approximate elevation at Barnwell on the Coast and Geodetic Survey precise level line.

The leveling was done in 1909 by L. F. Biggs without State cooperation.

[1] Determined by single unadjusted line by L. D. Ryus in 1901 from Fresno.

IVANPAH QUADRANGLE.

State line 11.6 miles east of Barnwell west along Atchison, Topeka & Santa Fe Railway to Barnwell (part of circuit from Las Vegas, Nev.).

	Feet.
Barnwell, 10 miles east of, in base of milepost 10; spike with aluminum tag stamped "4381"	4,378.36
Barnwell, 9 miles east of, in base of milepost 9; spike with aluminum tag stamped "4502"	4,499.59
Barnwell, 8.5 miles east of, 50 feet north of railroad, 150 feet east of milepost 9½; iron post stamped "4643 B 1909 18"	4,640.309
Hitt, 200 feet east of station, in base of telephone pole; spike with aluminum tag stamped "4611"	4,608.97
Barnwell, 5 miles east of, in base of milepost 5; spike with aluminum tag stamped "4599"	4,596.61
Barnwell, 4 miles east of, 50 feet north of railroad, 100 feet west of milepost 4; iron post stamped "4578 B 1909 19"	4,576.179
Barnwell, 3 miles east of, in base of milepost 3; spike with aluminum tag stamped "4543"	4,540.79
Barnwell, 2 miles east of, in base of first telephone pole east of milepost 2; spike with aluminum tag stamped "4610"	4,608.39
Barnwell, 1 mile east of, in base of milepost 1; spike with aluminum tag stamped "4702"	4,700.44
Barnwell, San Bernardino County, 72 feet east of Menvel Hotel, 39.36 feet east of east corner of Atchison, Topeka & Santa Fe Railway freight-house platform, 62.32 feet southeast of railroad track, on level with base of rail; square hole in top of stone post, set in sandy soil and dry clay, lettered "U. S. B. M."	4,807.325

Barnwell southwest along road to Government Holes, thence northwest to Cima, thence west to point 12 miles southeast of Silver Lake (portion of circuit via Silver Lake and Riggs, Cal., to Stump Springs, Nev., in which an excessive error has been adjusted).

Barnwell, 1.1 miles southwest of, west edge of road, in base of yucca tree; spike with aluminum tag stamped "4910"	4,910.51
Barnwell, 2.3 miles southwest of, east edge of road, in base of yucca tree; spike with aluminum tag stamped "5046"	5,045.65
Barnwell, 4 miles southwest of, 500 feet south of wash, on first slope of ridge, 50 feet north of road, east of New York Mountain triangulation station; iron post stamped "4957 B 1909 20"	4,956.552
Barnwell, 4.7 miles southwest of, east edge of road, east bank of wash, in yucca tree; spike with aluminum tag stamped "4807"	4,807.14
Barnwell, 6 miles southwest of, south edge of road, in base of yucca tree; spike with aluminum tag stamped "4871"	4,870.81
Barnwell, 7.3 miles southwest of, 300 feet south of junction of road to Youngs Camp, 50 feet west of road, on small knoll; iron post stamped "5119 B 1909 21"	5,118.186
Forks of road to Youngs Camp, 1.2 miles south of, 20 feet north of road, on summit between Government Holes and Barnwell, in base of yucca tree; spike with aluminum tag stamped "5200"	5,199.88
Forks of road to Youngs Camp, 2 miles southwest of, south edge of road on ridge between two washes, in base of yucca tree; spike with aluminum tag stamped "5109"	5,109.30
Government Holes, 4.7 miles northeast of, 60 feet north of road, in one of pile of granite bowlders; aluminum tablet stamped "5027 B 1909 22"	5,027.086
Government Holes, 3.3 miles northeast of, on point of ridge at junction of three washes, in stump; copper nail with aluminum tag stamped "4914"	4,913.93

Government Holes, 2.1 miles east of, at junction of road to Rock Springs, 1,000 feet north of spring, on bowlder painted "4776"; chisel point..... Feet. 4,776.18

Government Holes, 1.1 miles northeast of, 50 feet north of road, on large bowlder painted "4922"; chisel point..... 4,922.25

Government Holes, 1,000 feet northeast of house, 150 feet north of road, west edge of long granite bowlder; aluminum tablet stamped "5019 B 1909 23"..... 5,018.355

Government Holes, 1.9 miles northwest of, 60 feet north of road, on large flat at summit; iron post stamped "5167 B 1909 24"..... 5,166.517

Government Holes, 4.3 miles northwest of, north edge of road, at rocky point, on bowlder painted "4854"; chisel point..... 4,853.58

Government Holes, 5.1 miles northwest of, north edge of road, large bowlder painted "4705"; chisel point..... 4,704.33

Cima, 7.6 miles southeast of, 0.5 mile east of junction of old Government road to San Bernardino where road leaves Cedar Canyon, north edge of canyon, 50 feet west of road; iron post stamped "4625 B 1909 25"..... 4,624.917

Cima, 7 miles southeast of, at junction of old Government road, on bowlder painted "4480"; chisel point..... 4,480.08

Cima, 5.9 miles southeast of, west edge of road, in base of yucca tree; spike with aluminum tag stamped "4330"..... 4,329.69

Cima, 4.8 miles southeast of, 1.7 miles south of Death Valley mine, east edge of road, at base of round butte, in base of yucca tree; spike with aluminum tag stamped "4340"..... 4,339.84

Cima, 3.1 miles southeast of, 1,000 feet west of main building at Death Valley mine, 30 feet west of road; iron post stamped "4370 B 1909 26".. 4,369.643

Cima, 1.7 miles southeast of, west edge of road, 200 feet west of telephone line, in base of yucca tree; spike with aluminum tag stamped "4282"... 4,283.08

Cima, in front of San Pedro, Los Angeles & Salt Lake Railroad station; top of rail..... 4,188.5

Cima, 800 feet south of station, 2.5 telegraph poles south of milepost 254, west edge of right of way; iron post stamped "4204 B 1909 27"..... 4,203.623

Cima, 1.3 miles west of, south edge of road, in base of yucca tree; spike with aluminum tag stamped "4201"..... 4,200.85

Cima, 2.3 miles west of, south edge of road, in crotch of yucca tree; nail with aluminum tag stamped "4173"..... 4,182.44

Cima, 3.4 miles west of, 40 feet north of road; iron post stamped "4116 B 1909 28"..... 4,106.075

Cima, 4.7 miles west of, 50 feet south of road, in base of yucca tree; spike with aluminum tag stamped "4051"..... 4,050.13

Cima, 6.1 miles west of, 50 feet north of junction of old Government road to San Bernardino and road to Cima; iron post stamped "3932 B 1909 29".. 3,931.744

Cima, 7.2 miles west of, 1.2 miles west of forks of road, south edge of road at rock point, on bowlder painted "3817"; chisel point..... 3,817.97

Marl Spring, 1,000 feet northeast of, 50 feet north of road, on summit of ridge; iron post stamped "3904 B 1909 30"..... 3,903.752

Marl Spring, 1.8 miles northwest of, east edge of road, on summit of pass; iron post stamped "4556 B 1909 31"..... 4,555.877

Marl Spring, 3.7 miles west of, north edge of road, on bowlder painted "4079"; chisel point..... 4,098.50

Marl Spring, 4.7 miles west of, north edge of road, in top of stake; nail with aluminum tag stamped "3788"..... 3,807.38

Marl Spring, 5.8 miles west of, 1,000 feet west of place where road passes over hard formation, 500 feet west of large mesquite tree, 15 feet east of road; iron post stamped "3535 B 1909 32"..... 3,554.[illegible]

	Feet.
Marl Spring, 10.4 miles west of, south edge of wash, 100 feet south of large lava bowlder, 1 mile east of long black point, opposite middle one of three round buttes; iron post stamped "2762 B 1909 33"	2,761.566
Marl Spring, 11.4 miles west of, south edge of road, on bowlder painted "2602"; chisel point	2,600.77
17-Mile Point, 1.9 miles east of, at narrowest part of wash, south side of road, on bowlder painted "2213"; chisel point	2,212.34
17-Mile Point, 1 mile east of, 900 feet east of crossroad, south edge of wash, 100 feet west of two large bowlders in wash, in bedrock; aluminum tablet stamped "2106 B 1909 34"	2,105.069
17-Mile Point, 200 feet east of signboard, on extreme north point of granite bowlder painted "1965"; chisel point	1,964.02
17-Mile Point, 1 mile northwest of, north edge of road, on bowlder painted "1837"; chisel point	1,836.06
17-Mile Point, 4.6 miles northwest of, 12.2 miles southeast of Silver Lake, 30 feet north of road, at large flat; iron post stamped "1532 B 1909 35"	1,531.518

Kingston Spring northeast along road to Culver's ranch near State line (part of circuit from Barnwell in which an excessive error has been adjusted).

Kingston Spring, midway between spring and cabin; iron post stamped "2271 B 1909 45"	2,267.390
Kingston Spring, 3.3 miles northeast of, 50 feet south of road, 25 feet south of mesquite tree, on bowlder painted "2349"; chisel point	2,347.16
Kingston Spring, 5 miles northeast of, 200 feet north of junction of road to north, west end of small ridge; iron post stamped "2514 B 1909 46"	2,512.210
Kingston Spring, 6.7 miles northeast of, south edge of wash, 2,000 feet west of place where road leaves main wash, on black rocky point, in ledge; aluminum tablet stamped "2647 B 1909 47"	2,645.148
Kingston Spring, 10.3 miles northeast of, west edge of road, on bowlder painted "3173"; chisel point	3,171.53
Kingston Spring, 11.3 miles northeast of, 25 feet west of road where road leaves wash, 2 miles south of summit of pass; iron post stamped "3320 B 1909 48"	3,318.011
Kingston Spring, 13.5 miles northeast of, on summit of pass between Kingston Spring and Sandy, 15 feet east of road; iron post stamped "3585 B 1909 49"	3,582.710
Sandy, 10.3 miles west of, in forks of road to Horse Springs; iron post stamped "3145 B 1909 50"	3,143.097
Sandy, 9 miles west of, west edge of road, 0.5 mile south of point of long ridge, on bowlder painted "2978"; chisel point	2,976.67
Sandy, 5 miles west of, 0.5 mile north of Haverstick ranch, at junction of Sandy and Horse Springs roads; iron post stamped "2616 B 1909 51"	2,613.762
Haverstick ranch, 2.3 miles north of, in base of windmill tower; spike with aluminum tag stamped "2645"	2,642.97

CRUCERO QUADRANGLE.

Point 12 miles southeast of Silver Lake northwest to Silver Lake, thence north along Tonopah & Tidewater Railroad to Riggs, thence northeast to Kingston Springs (part of circuit from Barnwell in which an excessive error has been adjusted).

Silver Lake, 8.8 miles southeast of, 20 feet north of road; in large flat; iron post stamped "1386 B 1909 36"	1,385.050
Silver Lake, 5.7 miles east of, 25 feet north of road; iron post stamped "1150 B 1909 37"	1,148.552

	Feet.
Silver Lake, 4.3 miles east of, 15 feet south of road, on bowlder painted "1004"; chisel point	1,002.45
Silver Lake, 2.7 miles south of, 0.5 mile north of place where road enters bed of dry lake, 50 feet west of road; iron post stamped "908 B 1909 38"	907.209
Silver Lake, 1.3 miles south of, 30 feet west of road, on bowlder painted "908"; chisel point	905.79
Silver Lake, 150 feet south of Tonopah & Tidewater Railroad station, 100 feet north of water tank, north edge of right of way, 2 feet from telephone pole; iron post stamped "910 B 1909 39"	909.092
Silver Lake, 0.7 mile north of, in base of milepost 50; spike with aluminum tag stamped "939"	938.33
Silver Lake, 1.7 miles north of, in base of milepost 51; spike with aluminum tag stamped "942"	941.28
Silver Lake, 2.7 miles north of, in base of milepost 52; spike with aluminum tag stamped "928"	926.48
Silver Lake, 3.7 miles north of, east edge of right of way, at milepost 53; iron post stamped "910 B 1909 40"	908.791
Silver Lake, 4.7 miles north of, in base of milepost 54; spike with aluminum tag stamped "964"	962.97
Silver Lake, 5.7 miles north of, in base of milepost 55; spike with aluminum tag stamped "969"	968.16
Silver Lake, 6.7 miles north of, in base of milepost 56; spike with aluminum tag stamped "985"	984.37
Silver Lake, 7.7 miles north of, 2 feet from seventh telephone pole south of milepost 57, east edge of Tonopah & Tidewater Railroad right of way; iron post stamped "981 B 1909 41"	979.858
Riggs, 0.8 mile south of, in base of milepost 58; spike with aluminum tag stamped "970"	968.58
Riggs, in front of station; top of rail	969.3
Riggs, 1.3 miles north of, in base of milepost 60; spike with aluminum tag stamped "1035"	1,034.07
Riggs, 2.1 miles north of, north edge of Tonopah & Tidewater Railroad right of way, 20 feet north of milepost 61; iron post stamped "1103 B 1909 42"	1,101.411
Riggs, 3.2 miles north of, in base of milepost 62; spike with aluminum tag stamped "1080"	1,078.52
Milepost 63, Tonopah & Tidewater Railroad, 1.2 miles northeast of, 8 miles west of Kingston Spring, 25 feet north of road; iron post stamped "1410 B 1909 43"	1,408.641
Kingston Spring, 3.5 miles west of, 30 feet south of road, at small bare flat; iron post stamped "1926 B 1909 44"	1,925.122
Kingston Spring, 1 mile west of, north edge of wash, on black rocky point, on bowlder painted "2091"; chisel point	2,089.36

Hanford 30′ quadrangle.

KINGS COUNTY.

The elevations in the following list are based on the United States Geological Survey bench mark at Hanford, the accepted elevation of which is 250.385 feet.

The leveling was done in 1907 under the direction of the water-resources branch by W. V. Hardy.

HANFORD 30′ QUADRANGLE.

Hanford south along Atchison, Topeka & Santa Fe Railway to Corcoran (checked spur line).[1]

	Feet.
Hanford, east side of entrance to courthouse, in top of stone balustrade; bronze tablet stamped "250"	250.385
Hanford, 1.2 miles south of, 50 feet northwest of road crossing, 75 feet south of telegraph pole (M. P. 967), in base of telephone pole painted "U.S.G.S. B.M. 240"; spike	239.96
Hanford, 2 miles south of, at Brown's brickyard, west side of track, in base of telegraph pole; railroad spike marked "U.S.G.S.B.M."	241.82
Hanford, 3.4 miles south of, west side of track, in base of telegraph pole painted "U.S.B.M. 232"; railroad spike	232.00
Odessa, 350 feet south of signboard, west side of track, in base of telegraph pole (M. P. 964) painted "U.S.G.S.B.M. 232"; railroad spike	232.42
Odessa, 40 feet west of railroad, 15 feet north of wagon road, sec. 13, T. 19 S., R. 21 E.; iron post stamped "232 H."	231.939
Odessa, 1 mile south of, west side of track, in base of telegraph pole painted "U.S.G.S.B.M. 228;" railroad spike	227.51
Guernsey, 2 miles north of, west side of track, in base of telegraph pole (M. P. 962) painted "U.S.G.S.B.M. 222"; railroad spike	221.86
Guernsey, 1 mile northwest of, west side of track, in base of telegraph pole (M. P. 961) painted "U.S.G.S.B.M. 219"; railroad spike	218.91
Guernsey, in top of second post south of small flower lot; nail	223.25
Guernsey, 80 feet north of station, 30 feet west of track, at southeast corner of small park; iron post stamped "221 H."	220.891
Guernsey, 1 mile southeast of, west side of track, in base of telegraph pole (M. P. 959) painted "U.S.G.S.B.M. 216"; railroad spike	215.61
Guernsey, 2 miles southeast of, west side of track, in base of telegraph pole (M. P. 958) painted "U.S.G.S.B.M. 215"; railroad spike	215.28
Guernsey, 3 miles southeast of, west side of track, in base of telegraph pole (M. P. 957) painted "U.S.G.S.B.M. 213"; railroad spike	213.36
Cross Creek, on trestle; top of west rail	218.40
Guernsey, 4 miles southeast of, west side of track, in base of telegraph pole (M. P. 956) painted "U.S.G.S.B.M. 214"; railroad spike	213.47
Guernsey, 5 miles southeast of, west side of track, in base of telegraph pole (M. P. 955) painted "U.S.G.S.B.M. 210"; railroad spike	210.36
Bean, 1,000 feet northwest of, west side of track, in base of telegraph pole (M. P. 954) painted "U.S.G.S.B.M. 211"; spike	211.24
Bean, 1,000 feet northwest of station, 45 feet west of railroad track, 40 feet north of wagon road, on north boundary of sec. 3, T. 21 S., R. 22 E.; iron post stamped "211 H."	210.938
Corcoran, 2.1 miles northwest of, west side of track, in base of telegraph pole (M. P. 953) painted "U.S.G.S.B.M. 208"; railroad spike	208.06
Corcoran, 1.1 miles northwest of, west side of track, in base of telegraph pole (M. P. 952) painted "U.S.G.S.B.M. 204"; railroad spike	203.979
Corcoran, 0.5 mile northwest of, at road crossing; top of rail	208
Corcoran, hydrant at south end of schoolhouse; top of coupling	204.64
Corcoran, hotel, at foot of east stairway; north edge of east end of concrete doorsill	204.90
Corcoran, east side of schoolhouse, near south end of steps; iron post stamped "203 H."	202.927

[1] Permanent bench marks are on unchecked side shots.

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DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

BULLETIN 482

RESULTS OF SPIRIT LEVELING IN MONTANA

1896 TO 1910, INCLUSIVE

R. B. MARSHALL, CHIEF GEOGRAPHER

WASHINGTON
GOVERNMENT PRINTING OFFICE
1911

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GEOLOGICAL SURVEY BENCH MARKS

A, Tablet used in cooperating States. The State name is inserted at *G*.
B and *D*, Copper temporary bench mark, consisting of a nail and copper washer.
A, *C*, and *E*, Tablets for stone or concrete structures.
F, Iron post used where there is no rock.

RESULTS OF SPIRIT LEVELING IN MONTANA, 1896 TO 1910, INCLUSIVE.

R. B. MARSHALL, Chief Geographer.

INTRODUCTION.

Scope of the work.—All results of spirit leveling in Montana previously published by the United States Geological Survey and all the results of later work are included in this report, rearranged by quadrangles. Nearly all elevations are based on preliminary heights of bench marks along the precise level line of the Coast and Geodetic Survey from Ogden, Utah, via Pocatello, Idaho, Butte, Mont., and Sheridan, Wyo., to Crawford, Nebr., or on the checked primary leveling of the Missouri River Commission from the Montana-North Dakota State line along the Missouri River to Three Forks, Mont., and are subject to slight changes by future adjustments.

Personnel.—The field work from 1896 to 1906, inclusive, was done under the general direction of E. M. Douglas, geographer; that for 1907 to 1909, inclusive, under E. C. Barnard, geographer; and the later work under Sledge Tatum, geographer, under the general direction of R. B. Marshall, chief geographer. The names of the various levelmen are given in the introduction to each list. The office work of computation, adjustment, and preparation of lists was done mainly by S. S. Gannett, geographer, and D. H. Baldwin, topographer, and since 1907 under the general direction of E. M. Douglas, geographer.

Classification.—No precise leveling has been done by the United States Geological Survey in this State. For primary lines standard Y levels are used; lines are run in circuits or are closed on precise lines, with an allowable closing error in feet represented by 0.05 D, in which D is the length of the circuit in miles, sufficient care being given to the work to maintain this standard. For all levels of this class careful office adjustments are made, the circuit closure errors being distributed over the lines.

Bench marks.—The standard bench marks are of two forms. The first form is a circular bronze or aluminum tablet (*C* and *E*, Pl. I), 3½ inches in diameter and one-quarter inch thick having a 3-inch

stem, which is cemented in a drill hole in solid rock in the wall of some public building, a bridge abutment, or other substantial masonry structure. The second form (*F*, Pl. I), used where masonry or rock is not available, consists of a hollow wrought-iron post 3½ inches in outer diameter and 4 feet in length. The bottom is spread out to a width of 10 inches in order to give a firm bearing on the earth. A bronze or aluminum-bronze cap is riveted over the top of the post, which is set about 3 feet in the ground. A third style of bench mark with abbreviated lettering (*B* and *D*, Pl. I), is used for unimportant points. This consists of a special copper nail 1½ inches in length driven through a copper washer seven-eighths inch in diameter. The tablets as well as the caps on the iron posts are appropriately lettered. Cooperation by States is indicated by the addition of the State name (*G*, Pl. I).

The numbers stamped on the bench marks described in the following pages represent the elevations to the nearest foot as determined by the levelman. These numbers are stamped with $\frac{3}{16}$-inch steel dies on the tablets or post caps, to the left of the word "feet." The office adjustment of the notes and the reduction to mean sea level datum may so change some of the figures that the original markings are 1 or 2 feet in error. It is assumed that engineers and others who have occasion to use the bench-mark elevations will apply to the Director of the United States Geological Survey, at Washington, D. C., for the adjusted values and will use the markings as identification numbers only.

Datum.—All United States Geological Survey elevations are referred to mean sea level, which is the level that the sea would assume if the influence of winds and tides were eliminated. This level is not the elevation determined from the mean of the highest and the lowest tides, nor is it the half sum of the mean of all the high tides and the mean of all the low tides, which is called the half-tide level. *Mean sea level is the average height of the water, all stages of the tide being considered.* It is determined from observations made by means of tidal gages placed at stations where local conditions, such as long, narrow bays, rivers, and like features will not affect the height of the water. To obtain even approximately correct results these observations must extend over at least one lunar month, and if accuracy is desired they must extend over several years. At ocean stations the half-tide level and the mean sea level usually differ but little. It is assumed that there is no difference between the mean sea level as determined from observations in the Atlantic Ocean, the Gulf of Mexico, or the Pacific Ocean.

The connection with tidal stations for bench marks in certain areas that lie at some distance from the seacoast is still uncertain,

and this fact is indicated by the addition of a letter or word to the right of the word "DATUM" on tablets or posts. For such areas corrections for published results will be made from time to time as the precise-level lines of the United States Geological Survey or other Government organizations are extended.

Topographic maps.—Maps of the following quadrangles wholly or partly in Montana have been published by the United States Geological Survey up to June 20, 1911. They may be obtained, except as noted, for 5 cents each, or $3 a hundred, on application to the Director of the Survey, at Washington, D. C.

Aladdin (Wyo.-S. Dak.-Mont.)
Assinniboine.
Big Snowy Mountain.
Big Timber.
Bonner.
Boulder.[1]
Bowdoin.
Boxelder.
Browning.
Butte special.[2]
Chief Mountain.
Chinook.
Cœur d'Alene special (Idaho-Mont.)[2]
Coopers Lake.
Custer Battlefield.[3]
Dillon.
Fort Benton.
Fort Custer.
Fort Logan.
Glendive (Mont.-N. Dak.)
Great Falls.
Hamilton (Mont.-Idaho).
Harlem.
Havre.
Helena.[1]
Helena special.
Hinsdale special.
Huntley.
Kintla Lakes.
Kremlin.
Little Belt Mountains.
Livingston (Mont.-Yellowstone National Park).
Lonesome special.
Marysville special.
Ovando.
Philipsburg.
Rosebud.
Saco special.
St. Xavier.
Sapphire.
Saypo.
Stillwater.
Threeforks (Mont.-Yellowstone National Park).
Wayne Creek.
Yantic.

PRIMARY LEVELING.

Glendive Quadrangle.

DAWSON COUNTY.

The following bench marks along the west bank of Yellowstone River were established by the Reclamation Service in 1903, 1904, and 1906. The elevations have been reduced to approximate mean sea-level datum by adding 14.074 feet to Reclamation Service values.

The elevations given without fractions were determined by single level lines in the early stages of the Lower Yellowstone Project.

[1] Boulder map shows part of Helena quadrangle on larger scale.
[2] Price 10 cents.
[3] Custer Battlefield map shows also map of Custer Battlefield Reservation on scale of 1:5280.

GLENDIVE QUADRANGLE.

Terry along west side of Yellowstone River to Glendive.

	Feet.
Terry, 2 miles north of, about 3,500 feet below the Lower Terry Ferry; iron post	2,184
Terry, 6 miles north of, about 4.5 miles below the Lower Terry Ferry, 3,500 feet north of Haley Bros.' ranch houses; iron post	2,187
Fallon Ferry, 7,200 feet east and down river from, at lower end of Ferry Point; iron post	2,196
Lewis ranch houses, about 0.5 mile southeast of, 20 feet from edge of bank above wooded flat, about 540 feet southeast of southwest corner of NE. ¼ sec. 13, T. 13 N., R. 53 E.; iron post	2,148
Fallon Ferry, about 12 miles below; bench mark bears S. 51° E. from mouth of ravine and S. 36° E., about 500 feet from pointed butte at mouth of ravine; iron post	2,128
Yellowstone River, about 0.2 mile west of, on north bank of Clear Creek, bearing S. 33° 30′ W., to door of old dugout and N. 28° 45′ W., 0.4 mile to log house at foot of bluff; iron post	2,122
T. 15 N., R. 55 E., 0.2 mile due east from southwest corner of sec. 21; 0.8 mile east of Pepin's ranch, about 60 feet above river and 100 feet west of crest of cut bank; iron post	2,138
Glendive, 1 mile west of county bridge across Yellowstone River, on crest of high bank, 50 feet above road; log house on road bears S. 7° 30′ E., 50 rods from bench mark, county bridge bears N. 72° E.; iron post	2,121

Glendive down west side of Yellowstone River to Missouri River.

Glendive, 6 miles north of, 75 feet west of slough of Yellowstone River, 200 feet south of east-west line of fence, about 3,000 feet south of cabin, supposed to be in sec. 33, T. 17 N., R. 55 E.; iron post	2,080
Glendive, 10 miles northeast of, about 600 feet west of Yellowstone River at point on high bank extending east into river, and about 900 feet in south direction from quarter section corner on west side of sec. 18, T. 17 N., R. 56 E.; iron post	2,093
Glendive, 11 miles east of, on north side of mouth of Seven Mile Creek, 100 feet west of Yellowstone River, on top of large rock; cross	2,039
T. 17 N., R. 56 E., about 900 feet east of northeast corner of sec. 5, about 1,800 feet below Morgan Creek, 100 feet east of Glendive-Fort Buford County road, about 900 feet west of Yellowstone River, about 30 feet south of point of butte; iron post	2,052
Thirteenmile Creek, on flat 900 feet north of river road, 200 feet west of hills, on bank of creek near two small bullberry trees, on large rock; chisel mark	2,026
T. 18 N., R. 58 E., in sec. 36, 350 feet east by 135 feet south of northwest end of wing wall of headworks, 6 feet north by 48 feet east of southwest corner of gatekeeper's house; iron post	2,048.044
T. 18 N., R. 56 E., corner of secs. 25, 26, 35, and 36, on meander corner, 25 feet north of Yellowstone River, on edge of high cut bank, on top of stone; marked cross	2,054
Stewart's house, 3,000 feet northeast of, 100 feet north of road, near large rock monument about 700 feet southwest of Yellowstone River, on large rock; cross mark	2,024
T. 18 N., R. 57 E., in south part of sec. 17, 3 miles down river from Neil Stewart's ranch, on point of hill extending toward Yellowstone River, 300 feet west of road from Glendive to Fort Buford; iron post	1,989.468

	Feet.
T. 19 N., R. 57 E., 2,400 feet southeast of corner of secs. 26, 27, 34, and 35, 30 feet south of county road from Glendive to Buford, 125 feet north of Yackey's north line of fence and 1,300 feet east of Yackey's house, 600 feet west of Yackey's fence; iron post	2,024.665
T. 19 N., R. 58 E., near center of sec. 26, at Burns Creek, in small coulee which is about 200 feet north of Burns Creek, and 1,300 feet north of canal line; iron post	2,004.115
T. 19 N., R. 58 E., about 2,000 feet northwest of quarter section corner on south side of sec. 18, 800 feet northeast of Pettigrove's shack, 600 feet east of Glendive and Buford road, near where road leaves Tokna Flat to Glendive, 25 feet north of high bank and 4.5 miles south of Tokna; iron post	2,034.748
T. 19 N., R. 58 E., SE. ¼ SE. ¼ sec. 7, at mouth of Beef Slough, a few feet south of Beef Slough drain; iron post	1,979.114
Tokna, 600 feet east of Frederickson's house, 900 feet north of Dunlap Creek, 30 feet of north-south line of fence on east side of county road from Buford to Glendive, in SW. ¼ sec. 20, T. 20 N., R. 58 E.; iron post.	1,985.864
T. 20 N., R. 58 E., in sec. 21, 100 feet west of transit station 1105, 300 feet south of fence corner on Devitt ranch; iron post	2,009.734
T. 21 N., R. 58 E., in sec. 32, 6 feet south of Sear's east-west fence, 1,400 feet north of Sear's house, 600 feet north of Sears Creek bottom; iron post.	2,008.758
T. 21 N., R. 58 E., 0.5 mile west of J. A. Stewart's, 400 feet north of station 1506, 250 feet north of fence corner, 0.5 mile south of Crane Creek, near point of foothills, 20 feet west of tenth post north of fence corner; iron post	1,999.596
T. 12 N., R. 58 E., 1,365 feet west of northeast corner of sec. 10, 300 feet north af Meddie Simard's house, 3 feet south of Simard's east-west fence, about 4 miles southeast of Newlon post office; iron post	1,990.032
T. 22 N., R. 58 E., sec. 23, in Charles Stierle's front yard; iron post	1,953.789
T. 22 N., R. 58 E., near quarter section corner on west side of sec. 13, 2,000 feet east of Lowe's house, 100 feet west of small butte, on west side of north end of pass between Fox Creek and Lonetree Creek; iron post	1,994.045
Sidney, 1.25 miles southwest of, at quarter corner near old log house, 300 feet south of bank of Lonetree Creek and about 0.8 mile upstream from Lonetree; iron post	1,978.309
T. 23 N., R. 58 E., 700 feet east of southwest corner of sec. 16, on section line, 3,000 feet north of Kelly's house, 5,000 feet west of Anderson's house, 3 feet south of south line of section; iron post	1,987.056
T. 23 N., R. 59 E., in sec. 2, on section line halfway from Ridgelawn post office to Hastey's house, 1,000 feet west of county road; iron post	1,969.274
George Rhodes's house, 2,600 feet west of, 600 feet west of road between Buford and Glendive, halfway between First Hay and Second Hay Creeks, 700 feet from each; iron post	1,951.162
T. 24 N., R. 60 E., 2,300 feet west of corner of secs. 17, 18, 19, and 20, east side of county road, 0.5 mile southwest of J. Meador's; iron post	1,932.145
Fairview; 600 feet east of Newlon's store, 15 feet south of east-west line fence, 300 feet east of county road from Buford to Glendive; iron post.	1,938.293
T. 151 N., R. 104 W., near corner of secs. 17, 18, 19, and 20, 50 feet from road, 10 feet north of section line, west side of county road, 0.5 mile north of H. L. Moody's place; iron post (reset)	1,926.518
George Dore's house, 600 feet west of, 1,100 feet west of quarter section corner and county road, 50 feet south of east-west line fence; iron post.	1,926.286
T. 152 N., R. 105 W., 30 feet east by 55 feet south of corner of secs. 29, 30, 31, and 32; iron post	1,904.806

	Feet.
State line between North Dakota and Montana, 1.5 miles south of Missouri River, 50 feet north of Missouri River bluffs; iron post	1,898.224
Buford, N. Dak., 850 feet west of station, 98 feet south of center line of main track of Great Northern Ry., in southeast corner of fence on south side of Great Northern Ry. right of way, on north side of county road from Buford west to State line; iron post	1,961

Brocton, Milk River, Plentywood, Poplar, Scobey, Whiskey Buttes, and Wolf Point Quadrangles, and Quadrangle Two.

DAWSON AND VALLEY COUNTIES (FORT PECK INDIAN RESERVATION).

The following elevations are based upon Missouri River Commission leveling, as given in the Report of Chief of Engineers, United States Army, Part 4, 1894.

The work was done by the General Land Office. The iron posts at township corners are similar to those of the Geological Survey, but are 1 foot shorter. The interiors are filled with concrete. The iron section corner posts are of the same length (3 feet), 1 inch in diameter, filled with cement, capped, pointed at bottom, and driven in place with a maul. Elevations are stamped upon the posts at township corners and on many of those at section corners.

The leveling was done in the Brocton quadrangle in 1909 by Henry Bucher, H. L. Baldwin, L. E. Dequine, and L. B. Roberts; in the Milk River quadrangle in 1904 by E. W. Myers and F. E. Fellows, in 1908 by C. H. Burns, and in 1910 by H. L. Baldwin; in quadrangle 2, in 1910 by H. L. Baldwin; in the Plentywood and Scobey quadrangles in 1909 by Henry Bucher; in the Poplar quadrangle in 1908 by C. H. Burns, and in 1909 by L. B. Roberts and Henry Bucher; in the Wolf Point quadrangle in 1908 by C. H. Burns and J. S. Rohrer, in 1909 by Henry Bucher, and in 1910 by H. L. Baldwin; and in the Whiskey Buttes quadrangle in 1909 by Henry Bucher and in 1910 by H. L. Baldwin.

The leveling in the Brocton, Poplar, and Wolf Point quadrangles south of the Missouri River was done in 1910 by J. H. Wilke. Nearly all bench marks established by Wilke were by single unchecked sights and are therefore individually unreliable.

MILK RIVER QUADRANGLE.

T. 28 N., R. 40 E., southeast to Missouri River Commission bench mark 90/1.

	Feet.
T. 28 N., R. 40 E., 145 feet west of southeast corner of sec. 36, 9 miles southeast of Glasgow, 150 feet west of road, near mouth of coulee, toward west; iron post stamped "2085 MALTA"	2,092.465
T. 27 N., R. 41 E., 2 feet south of, northeast corner of sec. 8, 12 miles southeast of Glasgow; iron post stamped "2132 MALTA"	2,139.471
T. 27 N., R. 41 E., 2 feet south of quarter corner on east side of sec. 3, 14.5 miles southeast of Glasgow, 200 feet north of road, 200 feet west of slough, 900 feet south of Milk River; iron post stamped "2158 MALTA"	2,165.447

	Feet.
T. 27 N., R. 41 E., 2 feet south of northeast corner of sec. 27, 18 miles southeast of Glasgow, 500 feet south of base of bluff, 0.5 mile north of Missouri River, 0.5 mile east of Cowles house, 100 feet north of road, beside wire fence; iron post stamped "2047 MALTA"	2,054.418
Milk River and Missouri River. 3.5 miles west of junction of, 500 feet south of Missouri River, 1 mile northwest of Milk River, 3.75 miles southeast of Stephens ranch house; iron post stamped "Mo. River Commission U. S. B. M. 90/1 chart 57":	
Top of cap (Missouri River Commission bench mark)	2,091.869
Subsurface mark, under iron post	2,095.969

Northeast corner of sec. 27, T. 27 N., R. 41 E., east to point 3 miles north of mouth of Milk River (single spur line).

T. 27 N., R. 41 E., 3 feet south of northeast corner of sec. 13, 19 miles southeast of Glasgow, 200 feet north of gate in wire fence; iron post stamped "2104 MALTA"	2,111.408
T. 27 N., R. 42 E., near center of sec. 16, 2.5 miles southeast of Glasgow, 3 miles north of junction of Milk River and Missouri River, 1 mile west of Milk River; iron triangulation mark post set by Missouri River Commission Survey:	
Top of cap of iron post	2,182.746
Top of bolt under iron post	2,179.731
T. 27 N., R. 42 E., quarter corner on south side of sec. 22, 24.5 miles southeast of Glasgow, 0.25 mile west of Milk River, 2,000 feet north of log cabin; iron post stamped "2039 MALTA"	2,046.412

Glasgow southeast along Great Northern Ry. and highway to Missouri River Commission bench mark 92/2, 7 miles below mouth of Milk River (old double run line).

Whateley, east end of siding, in switch stand; top of southeast bolt	2,096.67
Nashua, east end of siding, south side of switchboard; head of bolt	2,071.21
Milk River station, water tank, 3 feet south of gauge rod, southeast corner of pedestal block; corner point	2,059.88
Bridge 325, 2.5 miles south of, 1,000 feet north of north bank of river, 7 miles below mouth of Milk River, on hill north of point at large bend in river, 600 feet east of house, Missouri River Commission bench mark 92/2:	
Subsurface mark under iron post	2,067.145
Top of cap of iron post	2,071.195

Bench mark 92/2 near mouth of Milk River north to point near Milk River station.

Missouri River Commission bench mark 91/2 on left bank, 1 mile below mouth of Milk River, 1,800 feet from shore	2,037.824
T. 27 N., R. 42 E., at quarter corner of sections 35 and 36; iron sec. post stamped "2044"	2,042.652
T. 27 N., R. 42 E., at corner of secs. 35, 36, 25, and 26; iron sec. post stamped "2045"	2,042.756
T. 27 N., R. 42 E., at quarter corner of secs. 25 and 26; iron sec. post stamped "2043"	2,041.526
Milk River station, 0.5 mile east of, 100 feet south of Great Northern Railway track, in northeast corner of lot around boat house; iron post stamped "2057"	2,056.413

Point near Milk River station east along railroad and road to Missouri River Commission bench mark 92/2.

Milk River station, 1 mile east of, south of track, in east end of wooden trestle; bolt marked "2073"	2,069.78

	Feet.
Milk River station, 1.6 miles east of, north of railroad 60 feet, in telegraph pole; spike stamped "2097"	2,092.41
Milk River station, 2.25 miles east of, south of railroad, in coping on west side of stone culvert; spike stamped "2111"	2,106.27
Kintyre, 1 mile west of, south of railroad, in station milepost; spike stamped "2100"	2,095.93
Kintyre, 30 feet north of track, in station signpost; spike stamped "2096"	2,092.50
Kintyre; top of rail	2,093.0
Kintyre, 1 mile east of, opposite milepost (signal), 100 feet south of railroad; iron post stamped "2085"	2,081.380
Frazer, 1 mile west of, south of railroad, in station milepost; spike marked "2071" (marked erroneously)	2,059.53
Frazer, southeast end of wooden trestle over Little Porcupine Creek, at rail joint; top of rail stamped "2074"	2,669.7
Frazer, 1 mile east of, north of track, in station milepost; spike stamped "2083"	2,078.61
T. 27 N., R. 44 E., quarter corner of secs. 34 and 35; iron section post stamped "2045" (marked erroneously)	2,070.039
Tps. 26 and 27 N., R. 44 E., corner of secs, 2, 3, 34, and 35; iron section post stamped "2088"	2,084.082
T. 26 N., R. 44 E., at quarter corner of secs. 2 and 3; iron section post stamped "2086"	2,081.240
Lenox, opposite, on east bank of river, 500 feet from bank, top of high bench, Missouri River Commission bench mark 93/2, plotted on chart 60:	
Subsurface mark under iron post	2,066.285
Top of cap of iron post	2,070.335

Bench mark 92/2 north to point 1 mile east of Kintyre.

T. 27 N., R. 43 E., quarter corner of secs. 35 and 36; iron section post	2,118.014

Milk River station northwest along Great Northern Ry. 2.2 miles, thence along road east and south to Milk River station.

Milk River, in front of station; top of rail	2,060.9
Tps. 27 and 28 N., R. 42 E., 100 feet west of, quarter corner of secs. 3 and 34, on small ridge; white stone 6 by 8 by 8 marked "2225"	2,224.76
Tps. 27 and 28 N., R. 42 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2248"	2,246.969
T. 27 N., R. 43 E., northwest corner of sec. 6; iron post stamped "2168"	2,167.252
Milk River Coulee, first west fork of; small stone marked "2117"	2,116.23

Point 2.2 miles northwest of Milk River station north and east to sec. 33, T. 29 N., R. 44 E.

Tps. 27 and 28 N., R. 42 E., corner of secs. 4, 5, 32, and 33, 6 feet northeast of iron section post; iron post stamped "2075"	2,073.937
T. 28 N., R. 42 E., corner of secs. 28, 29, 32, and 33; stone marked "2062"	2,261.07
T. 28 N., R. 42 E., corner of secs. 20, 21, 28, and 29; stone marked "2322"	2,321.45
T. 28 N., R. 42 E., quarter corner between secs. 20 and 21; stone marked "2329"	2,328.21
T. 28 N., R. 42 E., corner of secs. 16, 17, 20, and 21; iron section post stamped "2227"	2,225.908
T. 28 N., R. 42 E., quarter corner between secs. 16 and 17; stone marked "2342"	2,341.43
T. 28 N., R. 42 E., corner of secs. 8, 9, 16, and 17; stone marked "2351"	2,350.38
T. 28 N., R. 42 E., quarter corner between secs. 8 and 9; stone marked "2384"	2,383.12

	Feet.
T. 28 N., R. 42 E., corner of secs. 4, 5, 8, and 9; stone marked "2380"	2,379.09
T. 28 N., R. 42 E., quarter corner between secs. 4 and 5; iron section post stamped "2410"	2,409.626
T. 29 N., R. 42 E., south side of sec. 31, on standard quarter corner; iron section post stamped "2434"	2,432.943
T. 29 N., R. 42 E., standard corner of secs. 31 and 32; iron section post stamped "2450"	2,448.774
T. 29 N., R. 42 E., south side of sec. 32, standard quarter corner; iron section post stamped "2487"	2,485.958
T. 29 N., R. 42 E., standard corner of secs. 32 and 33; iron section post stamped "2482"	2,481.104
T. 29 N., R. 42 E., standard quarter corner of secs. 33; iron section post stamped "2494"	2,492.980
T. 29 N., R. 42 E., standard corner of secs. 33 and 34; iron section post stamped "2480"	2,478.937
T. 29 N., R. 42 E., standard quarter corner of sec. 34; iron section post stamped "2485"	2,484.107
T. 29 N., R. 42 E., standard corner of secs. 34 and 35; iron section post stamped "2469"	2,468.488
T. 28 N., Rs. 42 and 43 E., closing corner of; iron post stamped "2507"	2,505.775
T. 29 N., R. 42 E., standard quarter corner of sec. 35; iron section post stamped "2515"	2,513.771
T. 29 N., R. 42 E., standard quarter corner of sec. 36; iron section post stamped "2514"	2,513.067
T. 29 N., R. 42 and 43 E., standard corner of; iron post stamped "2533"	2,532.049
T. 28 N., R. 43 E., closing corner of secs. 4 and 5; iron section post stamped "2544"	2,544.564
T. 29 N., R. 43 E., standard quarter corner of sec. 31; iron section post stamped "2563"	2,561.982
T. 28 N., R. 43 E., quarter closing corner on north side of sec. 3; iron section post	2,576.66
T. 29 N., R. 43 E., standard corner of secs. 31 and 32; iron section post stamped "2580"	2,578.809
T. 28 N., R. 43 E., closing corner of secs. 3 and 4; iron section post	2,573.287
T. 29 N., R. 43 E., standard quarter corner of sec. 32; iron section post stamped "2592"	2,590.899
T. 28 N., R. 42 E., quarter closing corner of sec. 33; iron section post	2,592.390
T 29 N., R. 43 E., standard corner of secs. 32 and 33; iron section post stamped "2578"	2,576.821
T. 29 N., R. 43 E., standard quarter corner on south side of sec. 33, iron section post stamped "2540"	2,539.333
T. 28 N., R. 43 E., quarter closing corner sec. 2; iron section post	2,531.762
T. 29 N., R. 43 E., standard corner of secs. 33 and 34; iron section post stamped "2530"	2,529.409
T. 28 N., R. 43 E., closing corner of secs. 1 and 2; iron section post	2,587.15
T. 29 N., R. 43 E., standard quarter corner of sec. 34; iron section post stamped "2515" (stamped 100 feet low)	2,614.103
T. 28 N., R. 43 E., quarter closing corner of sec. 1; iron section post	2,588.430
T. 29 N., R. 43 E., standard corner of secs. 34 and 35; iron section post stamped "2536"	2,535.202
T. 28 N., Rs. 43 and 44 E., closing corner of; iron post stamped "2487"	2,485.999
T. 28 N., R. 43 E., quarter closing corner of sec. 6; iron section post stamped "2452"	2,451.615

	Feet.
T. 29 N., R. 43 E., standard corner of secs. 35 and 36; iron section post stamped "2414"	2,413.189
T. 28 N., R. 44 E., closing corner of secs. 5 and 6; iron section post stamped "2358"	2,356.740
T. 29 N., R. 43 E., standard quarter corner of sec. 36; stamped "2356"	2,354.94
T. 28 N., R. 44 E., quarter closing sec. 5; iron section post stamped "2389" (marked wrong)	2,377.742
T. 29 N., Rs. 43 and 44 E., standard corner of; iron post stamped "2425"	2,423.963
T. 28 N., R. 44 E., closing corner of secs. 4 and 5; stone	2,428.79
T. 29 N., R. 44 E., standard quarter corner of sec. 31; iron section post stamped "2429"	2,427.972
T. 28 N., R. 44 E., quarter closing corner of sec. 4; iron section stamped "2466"	2,464.840
T. 29 N., R. 44 E., standard corner of secs. 31 and 32; iron section post stamped "2508"	2,507.452
T. 28 N., R. 44 E., closing corner of secs. 3 and 4; iron section post stamped "2568"	2,567.28
T. 29 N., R. 44 E., standard quarter corner of sec. 32; iron section post stamped "2614"	2,612.817
T. 28 N., R. 44 E., quarter closing corner of sec. 3; iron section post stamped "2660"	2,659.658
T. 29 N., R. 44 E., standard corner of secs. 32 and 33; iron section post stamped "2596"	2,595.397
T. 28 N., R. 44 E., closing corner of secs. 2 and 3; iron section post stamped "2533"	2,532.135
T. 29 N., R. 44 E., standard quarter corner of sec. 33; iron section post stamped "2527"	2,526.317
T. 28 N., R. 44 E., quarter closing corner of sec. 2; iron section post stamped "2562"	2,560.983
T. 29 N., R. 44 E., standard corner of secs. 33 and 34; iron section post stamped "2592"	2,591.442
T. 28 N., R. 44 E., closing corner of secs. 1 and 2; iron section post stamped "2599"	2,598.093

Corner of secs. 3, 4, 33, and 34, Tps. 30 and 31 N., R. 44 E., west along township line between corner of secs. 5, 6, 31, and 32, R. 41 E., thence northwest to quarter corner between secs. 19 and 24, T. 31 N., Rs. 40–41 E., and north along range line to quarter corner between secs. 25 and 30, T. 32 N.

Tps. 30 and 31 N., R. 44 E., 75 feet south of quarter corner between secs. 4 and 5; red granite stone 1 by 2 feet, 8 inches above ground	2,842.81
Tps. 30 and 31 N., R. 44 E., corner secs. 5, 6, 31, and 32; iron section post stamped "2850"	2,848.600
Tps. 30 and 31 N., R. 44 E., quarter corner between secs. 6 and 31; iron section post stamped "2776"	2,775.073
Tps. 30 and 31 N., Rs. 43 and 44 E., corner of; iron post stamped "2674"	2,673.245
Tps. 30 and 31 N., R. 43 E., 33 feet east of quarter corner between secs. 1 and 36, small water-worn bowlder surrounded by circle of rocks	2,571.74
Tps. 30 and 31 N., R. 43 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2606"	2,604.629
Tps. 30 and 31 N., R. 43 E., quarter corner between secs. 2 and 35; iron section post stamped "2720"	2,718.589
Tps. 30 and 31 N., R. 43 E., corner of secs. 2, 3, 34 and 35; iron section post stamped "2742"	2,740.674
Tps. 30 and 31 N., R. 43 E., quarter corner between secs. 3 and 34; iron section post stamped "2867"	2,865.988

	Feet.
Tps. 30 and 31 N., R. 43 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2849"	2,848.074
Tps. 30 and 31 N., R. 43 E., quarter corner between secs. 4 and 33; iron section post stamped "2792"	2,791.108
Tps. 30 and 31 N., R. 43 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2837"	2,836.054
Tps. 30 and 31 N., R. 43 E., quarter corner between secs. 5 and 32; iron section post stamped "2856"	2,855.134
Tps. 30 and 31 N., R. 43 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "2854"	2,853.172
Tps. 30 and 31 N., Rs. 42 and 43 E., corner of; iron post stamped "2846"	2,844.916
Tps. 30 and 31 N., R. 42 E., 300 feet west of quarter corner between secs. 36 and 1; granite bowlder 2 by 2 by 1 foot above ground	2,803.88
Tps. 30 and 31 N., R. 42 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2774" (corner was moved after the elevation was taken, but is still correct to nearest foot)	2,773
Tps. 30 and 31 N., R. 42 E., 600 feet west of quarter corner between secs. 2 and 35; rock surrounded by circle of rocks	2,798.10
Tps. 30 and 31 N., R. 42 E., corner of secs. 2, 3, 34, and 35; iron section post stamped "2794"	2,793.065
Tps. 30 and 31 N., R. 42 E., near quarter corner between secs. 3 and 34; on small rock in circle of rocks	2,765.91
Tps. 30 and 31 N., R. 42 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2784"	2,783.360
Tps. 30 and 31 N., R. 42 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2761"	2,759.925
Tps. 30 and 31 N., R. 42 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "2698"	2,697.364
Tps. 30 and 31 N., R. 42 E., quarter corner between secs. 6 and 31; iron section post stamped "2595"	2,593.648
Tps. 30 and 31 N., R. 42 E., 200 feet south of creek; rock surrounded by a pile of rocks	2,561.66
Tps. 30 and 31 N., Rs. 41 and 42 E., corner of; iron post stamped "2603"	2,603.280
Tps. 30 and 31 N., R. 41 E., quarter corner between secs. 1 and 36; iron section post stamped "2581"	2,581.498
Tps. 30 and 31 N., R. 41 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2486"	2,486.267
Tps. 30 and 31 N., R. 41 E., corner of secs. 2, 3, 34, and 35; iron section post stamped "2553"	2,553.562
Tps. 30 and 31 N., R. 41 E., quarter corner between secs. 3 and 34; iron section post stamped "2587"	2,587.595
Tps. 30 and 31 N., R. 41 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2592"	2,592.630
Tps. 30 and 31 N., R. 41 E., quarter corner between secs. 4 and 33; iron section post stamped "2584"	2,584.543
Tps. 30 and 31 N., R. 41 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2562"	2,562.120
Tps. 30 and 31 N., R. 41 E., quarter corner between secs. 5 and 32; iron section post stamped "2467"	2,467.612
Tps. 30 and 31 N., R. 41 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "2425"	2,425.549
Tps. 30 and 31 N., R. 41 E., near corner of secs. 5, 6, 31, and 32; rock	2,425.49
Tps. 30 and 31 N., R. 41 E., quarter corner between secs. 31 and 6; iron post stamped "2428"	2,428.275

	Feet.
T. 31 N., R. 41 E., quarter corner between secs. 29 and 30; iron section post stamped "2522"	2,522.169
T. 31 N., R. 41 E., quarter corner between secs. 19 and 30; iron section post stamped "2513"	2,513.734
T. 31 N., Rs. 40 and 41 E., quarter corner between secs. 19 and 24; iron section post stamped "2494"	2,494.516
T. 31 N., Rs. 40 and 41 E., corner of secs. 13, 18, 19, and 24; iron section post stamped "2525"	2,525.795
T. 31 N., Rs. 40 and 41 E., quarter corner between secs. 13 and 18; iron section post stamped "2563"	2,563.408
T. 31 N., Rs. 40 and 41 E., corner of secs. 7, 12, 13, and 18; iron section post stamped "2556"	2,556.749
T. 31 N., Rs. 40 and 41 E., quarter corner between secs. 7 and 12; iron section post stamped "2621"	2,621.478
T. 31 N., Rs. 40 and 41 E., corner of secs. 1, 6, 7, and 12; iron section post stamped "2648"	2,648.863
T. 31 N., Rs. 40 and 41 E., quarter corner between secs. 1 and 6; iron section post stamped "2637"	2,637.294
Tps. 31 and 32 N., Rs. 40 and 41 E., corner common to; iron post stamped "2669"	2,669.986
T. 32 N., Rs. 40 and 41 E., corner of secs. 25, 30, 31, and 36; iron section post stamped "2741"	2,741.980
T. 32 N., Rs. 40 and 41 E., quarter corner between secs. 25 and 30; iron section post stamped "2772"	2,772.692

Quarter corner of sec. 31, T. 29 N., R. 42 E., north along range line between Rs. 41 and 42 E., to quarter corner between secs. 1 and 6, T. 30.[1]

T. 29 N., R. 42 E., witness corner to standard quarter corner of sec. 31; iron section post stamped "2434"	2,432.943
T. 38 N., Rs. 41 and 42 E., witness corner, standard quarter corner of secs. 4 and 5; iron section post stamped "2422"	2,420.944
T. 29 N., Rs. 41 and 42 E., standard corner; iron post stamped "2409"	2,408.288
T. 29 N., Rs. 41 and 42 E., quarter corner between secs. 31 and 36; iron section post stamped "2416"	2,415.466
T. 29 N., Rs. 41 and 42 E., corner of secs. 25, 30, 31, and 36; iron section post stamped "2420"	2,419.268
T. 29 N., Rs. 41 and 42 E., quarter corner between secs. 25 and 30; iron section post stamped "2448"	2,446.626
T. 29 N., Rs. 41 and 42 E., corner of secs. 19, 24, 25, and 30; iron section post stamped "2464"	2,462.780
T. 29 N., Rs. 41 and 42 E., quarter corner between secs. 19 and 24; iron section post stamped "2482"	2,480.557
T. 29 N., Rs. 41 and 42 E., corner of secs. 13, 18, 19, and 24; iron section post stamped "2528"	2,526.640
T. 29 N., Rs. 41 and 42 E., quarter corner between secs. 13 and 18; iron section post stamped "2533"	2,531.910
T. 29 N., Rs. 41 and 42 E., corner of secs. 7, 12, 13, and 18; iron section post stamped "2497"	2,495.880
T. 29 N., Rs. 41 and 42 E., quarter corner between secs. 7 and 12; iron section post stamped "2531"	2,529.734
T. 29 N., Rs. 41 and 42 E., corner of secs. 1, 6, 7, and 12; iron section post stamped "2560"	2,558.841

[1] Unadjusted line closing 1.511 feet low on adjusted line.

	Feet.
T. 29 N., Rs. 41 and 42 E., quarter corner between secs. 1 and 6; iron section post stamped "2614"	2,612.704
Tps. 29 and 30 N., Rs. 41 and 42 E., corner of; iron post stamped "2568"	2,566.907
T. 30 N., Rs. 41 and 42 E., quarter corner between secs. 31 and 36; iron section post stamped "2534"	2,533.106
T. 30 N., Rs. 41 and 42 E., corner of secs. 25, 30, 31, and 36; iron section post stamped "2595"	2,593.747
T. 30 N., Rs. 41 and 42 E., quarter corner between secs. 25 and 30; iron section post stamped "2695"	2,694.171
T. 30 N., Rs. 41 and 42 E., corner of secs. 24, 25, 19, and 30; iron section post stamped "2608"	2,607.166
T. 30 N., Rs. 41 and 42 E., quarter corner between secs. 19 and 24; iron section post stamped "2669"	2,667.954
T. 30 N., Rs. 41 and 42 E., quarter corner between secs. 13 and 18; iron section post stamped "2737"	2,736.247
T. 30 N., Rs. 41 and 42 E., corner of secs. 7, 12, 13, and 18; iron section post stamped "2745"	2,744.155
T. 30 N., Rs. 41 and 42 E., quarter corner between secs. 7 and 12; iron section post stamped "2695"	2,694.313
T. 30 N., Rs. 41 and 42 E., corner of secs. 1, 6, 7, and 12; iron section post stamped "2721"	2,719.657
T. 30 N., Rs. 41 and 42 E., quarter corner between secs. 1 and 6; iron section post stamped "2615"	2,614.032

WOLF POINT 30′ QUADRANGLE.

Missouri River Commission bench mark 98/2 east, north, east, and south along township and range lines to Missouri River Commission bench mark 98/2.

Tps. 26 and 27 N., R. 44 E., corner of secs. 2, 3, 34, and 35; iron section post stamped "2084"	2,084.082
Tps. 26 and 27 N., R. 44 E., quarter corner between secs. 5 and 32; iron section post stamped "2089"	2,088.642
T. 27 N., R. 44 E., south side of sec. 36, on sixteenth corner; top of white limestone 8 by 8 inches and 4 inches above ground, marked "2036"	2,035.88
Tps. 26 and 27 N., R. 44 E., quarter corner between secs. 1 and 36; iron section post stamped "2031"	2,031.233
Tps. 26 and 27 N., Rs. 44 and 45 E., corner of; iron post stamped "2030"	2,029.941
T. 27 N., Rs. 44 and 45 E., quarter corner between secs. 25 and 30; iron section post stamped "2109"	2,108.645
T. 27 N., Rs. 44 and 45 E., corner of secs. 19, 24, 25, and 30; iron section post stamped "2146"	2,146.025
T. 27 N., R. 44 E., center of sec. 24; iron section post stamped "2185"	2,184.660
T. 27 N., Rs. 44 and 45 E., corner of secs. 13, 18, 19, and 24; iron section post stamped "2198"	2,199.117
T. 27 N., Rs. 44 and 45 E., quarter corner between secs. 13 and 18; iron section post stamped "2201"	2,201.530
T. 27 N., Rs. 44 and 45 E., corner of secs. 7, 12, 13, and 18; iron section post stamped "2223"	2,223.755
T. 27 N., Rs. 44 and 45 E., quarter corner between secs. 7 and 12; iron section post stamped "2276"	2,276.963
T. 27 N., Rs. 44 and 45 E., corner of secs 1, 6, 7, and 12; iron section post stamped "2274"	2,274.852
T. 27 N., Rs. 44 and 45 E., quarter corner between secs. 1 and 6; iron section post stamped "2273"	2,273.806
Tps. 27 and 28 N., Rs. 44 and 45 E., corner of; iron post stamped "2280"	2,281.137

	Feet.
T. 31 N., R. 41 E., quarter corner between secs. 29 and 30; iron section post stamped "2522"	2,522.169
T. 31 N., R. 41 E., quarter corner between secs. 19 and 30; iron section post stamped "2513"	2,513.734
T. 31 N., Rs. 40 and 41 E., quarter corner between secs. 19 and 24; iron section post stamped "2494"	2,494.516
T. 31 N., Rs. 40 and 41 E., corner of secs. 13, 18, 19, and 24; iron section post stamped "2525"	2,525.795
T. 31 N., Rs. 40 and 41 E., quarter corner between secs. 13 and 18; iron section post stamped "2563"	2,563.408
T. 31 N., Rs. 40 and 41 E., corner of secs. 7, 12, 13, and 18; iron section post stamped "2556"	2,556.749
T. 31 N., Rs. 40 and 41 E., quarter corner between secs. 7 and 12; iron section post stamped "2621"	2,621.478
T. 31 N., Rs. 40 and 41 E., corner of secs. 1, 6, 7, and 12; iron section post stamped "2648"	2,648.863
T. 31 N., Rs. 40 and 41 E., quarter corner between secs. 1 and 6; iron section post stamped "2637"	2,637.294
Tps. 31 and 32 N., Rs. 40 and 41 E., corner common to; iron post stamped "2669"	2,669.986
T. 32 N., Rs. 40 and 41 E., corner of secs. 25, 30, 31, and 36; iron section post stamped "2741"	2,741.980
T. 32 N., Rs. 40 and 41 E., quarter corner between secs. 25 and 30; iron section post stamped "2772"	2,772.692

Quarter corner of sec. 31, T. 29 N., R. 42 E., north along range line between Rs. 41 and 42 E., to quarter corner between secs. 1 and 6, T. 30.[1]

T. 29 N., R. 42 E., witness corner to standard quarter corner of sec. 31; iron section post stamped "2434"	2,432.943
T. 38 N., Rs. 41 and 42 E., witness corner, standard quarter corner of secs. 4 and 5; iron section post stamped "2422"	2,420.944
T. 29 N., Rs. 41 and 42 E., standard corner; iron post stamped "2409"	2,408.288
T. 29 N., Rs. 41 and 42 E., quarter corner between secs. 31 and 36; iron section post stamped "2416"	2,415.466
T. 29 N., Rs. 41 and 42 E., corner of secs. 25, 30, 31, and 36; iron section post stamped "2420"	2,419.268
T. 29 N., Rs. 41 and 42 E., quarter corner between secs. 25 and 30; iron section post stamped "2448"	2,446.626
T. 29 N., Rs. 41 and 42 E., corner of secs. 19, 24, 25, and 30; iron section post stamped "2464"	2,462.780
T. 29 N., Rs. 41 and 42 E., quarter corner between secs. 19 and 24; iron section post stamped "2482"	2,480.557
T. 29 N., Rs. 41 and 42 E., corner of secs. 13, 18, 19, and 24; iron section post stamped "2528"	2,526.640
T. 29 N., Rs. 41 and 42 E., quarter corner between secs. 13 and 18; iron section post stamped "2533"	2,531.910
T. 29 N., Rs. 41 and 42 E., corner of secs. 7, 12, 13, and 18; iron section post stamped "2497"	2,495.830
T. 29 N., Rs. 41 and 42 E., quarter corner between secs. 7 and 12; iron section post stamped "2531"	2,529.734
T. 29 N., Rs. 41 and 42 E., corner of secs. 1, 6, 7, and 12; iron section post stamped "2560"	2,558.841

[1] Unadjusted line closing 1.511 feet low on adjusted line.

	Feet.
T. 29 N., Rs. 41 and 42 E., quarter corner between secs. 1 and 6; iron section post stamped "2614"	2,612.704
Tps. 29 and 30 N., Rs. 41 and 42 E., corner of; iron post stamped "2568"	2,566.907
T. 30 N., Rs. 41 and 42 E., quarter corner between secs. 31 and 36; iron section post stamped "2534"	2,533.106
T. 30 N., Rs. 41 and 42 E., corner of secs. 25, 30, 31, and 36; iron section post stamped "2595"	2,593.747
T. 30 N., Rs. 41 and 42 E., quarter corner between secs. 25 and 30; iron section post stamped "2695"	2,694.171
T. 30 N., Rs. 41 and 42 E., corner of secs. 24, 25, 19, and 30; iron section post stamped "2608"	2,607.166
T. 30 N., Rs. 41 and 42 E., quarter corner between secs. 19 and 24; iron section post stamped "2669"	2,667.954
T. 30 N., Rs. 41 and 42 E., quarter corner between secs. 13 and 18; iron section post stamped "2737"	2,736.247
T. 30 N., Rs. 41 and 42 E., corner of secs. 7, 12, 13, and 18; iron section post stamped "2745"	2,744.155
T. 30 N., Rs. 41 and 42 E., quarter corner between secs. 7 and 12; iron section post stamped "2695"	2,694.313
T. 30 N., Rs. 41 and 42 E., corner of secs. 1, 6, 7, and 12; iron section post stamped "2721"	2,719.657
T. 30 N., Rs. 41 and 42 E., quarter corner between secs. 1 and 6; iron section post stamped "2615"	2,614.032

WOLF POINT 30′ QUADRANGLE.

Missouri River Commission bench mark 98/2 east, north, east, and south along township and range lines to Missouri River Commission bench mark 98/2.

Tps. 26 and 27 N., R. 44 E., corner of secs. 2, 3, 34, and 35; iron section post stamped "2084"	2,084.082
Tps. 26 and 27 N., R. 44 E., quarter corner between secs. 5 and 32; iron section post stamped "2089"	2,088.642
T. 27 N., R. 44 E., south side of sec. 36, on sixteenth corner; top of white limestone 8 by 8 inches and 4 inches above ground, marked "2036"	2,035.88
Tps. 26 and 27 N., R. 44 E., quarter corner between secs. 1 and 36; iron section post stamped "2031"	2,031.233
Tps. 26 and 27 N., Rs. 44 and 45 E., corner of; iron post stamped "2030"	2,029.941
T. 27 N., Rs. 44 and 45 E., quarter corner between secs. 25 and 30; iron section post stamped "2109"	2,108.645
T. 27 N., Rs. 44 and 45 E., corner of secs. 19, 24, 25, and 30; iron section post stamped "2146"	2,146.025
T. 27 N., R. 44 E., center of sec. 24; iron section post stamped "2185"	2,184.660
T. 27 N., Rs. 44 and 45 E., corner of secs. 13, 18, 19, and 24; iron section post stamped "2198"	2,199.117
T. 27 N., Rs. 44 and 45 E., quarter corner between secs. 13 and 18; iron section post stamped "2201"	2,201.530
T. 27 N., Rs. 44 and 45 E., corner of secs. 7, 12, 13, and 18; iron section post stamped "2223"	2,223.755
T. 27 N., Rs. 44 and 45 E., quarter corner between secs. 7 and 12; iron section post stamped "2276"	2,276.963
T. 27 N., Rs. 44 and 45 E., corner of secs 1, 6, 7, and 12; iron section post stamped "2274"	2,274.852
T. 27 N., Rs. 44 and 45 E., quarter corner between secs. 1 and 6; iron section post stamped "2273"	2,273.806
Tps. 27 and 28 N., Rs. 44 and 45 E., corner of; iron post stamped "2280"	2,281.137

	Feet.
Tps. 27 and 28 N., R. 45 E., quarter corner between secs. 6 and 31; iron section post stamped "2278"	2,277.808
Tps. 27 and 28 N., R. 45 E., corner of secs. 5, 6, 31, and 32; iron post stamped "2276"	2,276.425
Tps. 27 and 28 N., R. 45 E., quarter corner between secs. 5 and 32; iron section post stamped "2270"	2,271.174
Tps. 27 and 28 N., R. 45 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2275"	2,275.629
Tps. 27 and 28 N., R. 45 E., quarter corner between secs. 4 and 33; iron section post stamped "2265"	2,265.906
Tps. 27 and 28 N., R. 45 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2263"	2,263.870
Tps. 27 and 28 N., R. 45 E., quarter corner between secs. 3 and 34; iron section post stamped "2271"	2,271.951
Tps. 27 and 28 N., R. 45 E., corner of secs. 2, 3, 34, and 35; iron section post stamped "2279"	2,279.727
Tps. 27 and 28 N., R. 42 E., quarter corner between secs. 2 and 35; iron section post stamped "2286"	2,287.074
Tps. 27 and 28 N., R. 45 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2287"	2,287.739
Tps. 27 and 28 N., R. 45 E., quarter corner between secs. 1 and 36; iron section post stamped "2264"	2,264.744
Tps. 27 and 28 N., Rs. 45 and 46 E., corner of; iron post stamped "2284"	2,285.206
Tps. 27 and 28 N., R. 46 E., quarter corner between secs. 6 and 31; stone marked "2279"	2,279.29
Tps. 27 and 28 N., R. 46 E., corner of secs. 5, 6, 31, and 32; stone marked "2283"	2,283.72
Tps. 27 and 28 N., R. 46 E., quarter corner between secs. 5 and 32; stone marked "2269"	2,269.77
Tps. 27 and 28 N., R. 46 E., corner of secs. 4, 5, 32, and 33; stone marked "2260"	2,260.52
Tps. 27 and 28 N., R. 46 E., quarter corner between secs. 4 and 33; stone marked "2259"	2,259.61
Tps. 27 and 28 N., R. 46 E., corner of secs. 3, 4, 33, and 34; stone marked "2281"	2,282.05
Tps. 27 and 28 N., R. 46 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2282"	2,282.947
Tps. 27 and 28 N., R. 46 E., quarter corner between secs. 3 and 34; stone marked "2279"	2,280.19
Tps. 27 and 28 N., R. 46 E., corner of secs. 2, 3, 34, and 35; stone marked "2241"	2,241.86
Tps. 27 and 28 N., R. 46 E., quarter corner between secs. 2 and 35; stone marked "2265"	2,265.48
Tps. 27 and 28 N., R. 46 E., corner of secs. 1, 2, 35, and 36; stone marked "2209"	2,209.65
Tps. 27 and 28 N., R. 46 E., quarter corner between secs. 1 and 36; stone marked "2261"	2,261.63
Tps. 27 and 28 N., R. 46 E., standard corner of range line between ranges 46 and 47 E.; iron post stamped "2077"	2,078.168
Tps. 27 and 28 N., R. 47 E., closing corner; iron post stamped "2075"	2,073.900
Tps. 27 and 28 N., R. 47 E., quarter corner between secs. 6 and 31; stone marked "2248"	2,248.50
Tps. 27 and 28 N., R. 47 E., corner of secs. 5, 6, 31, and 32; stone marked "2237"	2,238.01

	Feet.
Tps. 27 and 28 N., R. 47 E., quarter corner between secs. 5 and 32; stone marked "2195"	2,195.47
Tps. 27 and 28 N., R. 47 E., corner of secs. 4, 5, 32, and 33; stone marked "2171"	2,172.00
Tps. 27 and 28 N., R. 47 E., quarter corner between secs. 4 and 33; stone marked "2189"	2,189.89
Tps. 27 and 28 N., R. 47 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2171"	2,171.448
Tps. 27 and 28 N., R. 47 E., quarter corner between secs. 3 and 34; stone marked "2233"	2,234.18
Tps. 27 and 28 N., R. 47 E., corner of secs. 2, 3, 34, and 35; stone marked "2122"	2,123.05
Tps. 27 and 28 N., R. 47 E., quarter corner between secs. 2 and 35, 100 feet east of stone; white limestone, 12 by 8 by 5 inches, surrounded by stone pile marked "2134"	2,134.244
Tps. 27 and 28 N., R. 47 E., corner of secs. 1, 2, 35, and 36; stone marked "2164"	2,164.88
Tps. 27 and 28 N., R. 47 E., quarter corner between secs. 1 and 36; stone marked "2085"	2,085.45
Tps. 27 and 28 N., Rs. 47 and 48 E., corner of; iron post stamped "2126"	2,127.168
T. 27 N., Rs. 47 and 48 E., quarter corner between secs. 1 and 6; stone marked "2060"	2,060.96
T. 27 N., Rs. 47 and 48 E., corner of secs. 1, 6, 7, and 12; stone marked "2039"	2,039.42
T. 27. N., Rs. 47 and 48 E., quarter corner between secs. 7 and 12; stone marked "1990"	1,991.05
Wolf Point, 2.5 miles east of railway station, on east bank of Missouri River, 665 feet west of railway bridge, 75 feet north of wagon road; Missouri River Commission Bench Mark 98/2, plotted on chart 64 of Missouri River Commission:	
Subsurface mark under iron post	1,985.741
Top of cap of iron post	1,989.791

Sec. 33, T. 29 N., R. 44 E., east along township line to sec. 32, T. 29 N., R. 48 E.

T. 29 N., R. 44 E., 150 feet east of standard quarter corner of sec. 34; white limestone, 8 by 6 by 4 inches, marked "2580"	2,578.843
T. 28 N., R. 44 E., quarter closing corner of sec. 1; iron section post stamped "2599"	2,598.096
T. 29 N., R. 44 E., standard corner of secs. 34 and 35; iron section post stamped "2618"	2,617.065
T. 28 N., Rs. 44 and 45 E., closing corner of; iron post stamped "2613"	2,611.699
T. 29 N., R. 44 E., standard quarter corner of sec. 35; iron section post stamped "2600"	2,598.672
T. 28 N., R. 45 E., quarter closing corner of sec. 6; iron section post stamped "2626"	2,625.318
T. 29 N., R. 44 E., standard corner of secs. 35 and 36; iron section post stamped "2686"	2,685.587
T. 28 N., R. 45 E., closing corner of secs. 5 and 6; iron section post stamped "2705"	2,703.740
T. 29 N., R. 44 E., standard quarter corner of sec. 36; iron section post stamped "2711"	2,709.923
T. 28 N., R. 44 E., quarter closing corner of sec. 5; iron section post stamped "2697"	2,696.544
T. 29 N., Rs. 44 and 45 E., standard corner of; iron post stamped "2709"	2,708.490

	Feet.
T. 28 N., R. 44 E., closing corner of secs. 4 and 5; iron section post stamped "2707"	2,705.71
T. 29 N., R. 45 E., quarter closing corner of sec. 31; iron section post stamped "2683"	2,681.99
T. 28 N., R. 45 NW. ¼ sec. 4, White Rock triangulation station; iron post stamped "2740"	2,739.07
T. 29 N., R. 45 E., standard quarter corner of sec. 31; iron section post stamped "2683"	2,681.99
T. 28 N., R. 45 E., quarter closing corner of sec. 4; iron section post stamped "2668"	2,667.38
T. 29 N., R. 45 E., standard corner of secs. 31 and 32; iron section post stamped "2689"	2,687.66
T. 28 N., R. 45 E., closing corner secs. 3 and 4; iron section post stamped "2713"	2,712.49
T. 29 N., R. 45 E., standard quarter corner of sec. 32; iron section post stamped "2706"	2,704.80
T. 28 N., R. 45 E., quarter closing corner of sec. 3; iron section post stamped "2686"	2,684.83
T. 29 N., R. 45 E., standard corner of secs. 32 and 33; iron section post stamped "2672"	2,671.21
T. 29 N., R. 45 E., standard quarter corner of sec. 33; iron section post stamped "2669"	2,668.277
T. 28 N., R. 45 E., quarter closing corner of sec. 2; iron section post stamped "2631"	2,629.568
T. 29 N., R. 45 E., standard corner of secs. 33 and 34; iron section post stamped "2667"	2,666.013
T. 28 N., R. 45 E., closing corner of secs. 1 and 2; iron section post stamped "2704"	2,702.565
T. 29 N., R. 45 E., standard quarter corner of sec. 34; iron section post stamped "2654"	2,653.230
T. 28 N., R. 45 E., quarter closing corner of sec. 1; iron section post stamped "2657"	2,656.365
T. 29 N., R. 45 E., standard corner of secs. 34 and 35; iron section post stamped "2614"	2,612.930
T. 28 N., Rs. 45 and 46 E., closing corner of; iron post stamped "2705"	2,703.675
T. 29 N., R. 45 E., standard quarter corner of sec. 35; iron section post stamped "2705"	2,703.668
T. 28 N., R. 46 E., quarter closing corner of sec. 6; iron section post stamped "2660"	2,659.136
T. 28 N., R. 46 E., closing corner of secs. 5 and 6; iron section post stamped "2639"	2,638.541
T. 29 N., R. 45 E., standard quarter corner of sec. 36; iron section post stamped "2517"	2,516.648
T. 29 N., Rs. 45 and 46 E., corner of; iron post stamped "2472"	2,470.725
T. 28 N., R. 46 E., closing corner of secs. 4 and 5; iron section post stamped "2490"	2,488.542
T. 29 N., R. 46 E., standard quarter corner of sec. 31; stamped "2496"	2,495.03
T. 28 N., R. 46 E., quarter closing corner of sec. 4; iron section post stamped "2486"	2,485.006
T. 29 N., R. 46 E., standard corner of secs. 31 and 32; iron section post stamped "2440"	2,438.602
T. 28 N., R. 46 E., closing corner of secs. 3 and 4; iron section post stamped "2416"	2,415.966

	Feet.
T. 29 N., R. 46 E., standard quarter corner of sec. 32; iron section post stamped "2399"	2,398.394
T. 28 N., R. 46 E., quarter closing corner of sec. 3; iron section post stamped "2396"	2,394.733
T. 29 N., R. 46 E., standard corner of secs. 32 and 33; iron section post stamped "2314"	2,313.221
T. 28 N., R. 46 E., closing corner of secs. 2 and 3; iron section post stamped "2273"	2,271.692
T. 29 N., R. 46 E., standard quarter corner of sec. 33; iron section post stamped "2290"	2,291.213
T. 28 N., R. 46 E., quarter closing corner of sec. 2; iron section post stamped "2321"	2,320.406
T. 29 N., R. 46 E., standard section corner of secs. 33 and 34; iron section post stamped "2393"	2,392.405
T. 28 N., R. 46 E., closing corner of secs. 1 and 2; iron section post stamped "2391"	2,389.640
T. 29 N., R. 46 E., standard quarter corner of sec. 34; iron section post stamped "2408"	2,406.550
T. 28 N., R. 46 E., quarter closing corner of sec. 1; iron section post stamped "2429"	2,427.712
T. 29 N., R. 46 E., standard corner of secs. 34 and 35; iron section post stamped "2460"	2,458.99
T. 28 N., Rs. 46 and 47 E., closing corner of; iron post stamped "2496"	2,494.782
T. 28 N., R. 47 E., quarter closing corner of sec. 6; iron section post stamped "2654"	2,652.940
T. 28 N., R. 47 E., in northeast quarter of sec. 6, triangulation station "Bone;" iron post stamped "2679"	2,678.160
T. 28 N., R. 47 E., closing corner of secs. 5 and 6; iron section post stamped "2549"	2,547.865
T. 29 N., R. 46 E., standard quarter corner of sec. 36; iron section post stamped "2568"	2,566.612
T. 28 N., R. 47 E., quarter closing corner of sec. 5; iron section post stamped "2565"	2,563.528
T. 29 N., R. 46 E., southeast corner of; iron post stamped "2556"	2,554.447
T. 29 N., R. 47 E., southwest corner of; iron post stamped "2532"	2,530.506
T. 28 N., R. 47 E., closing corner of secs. 4 and 5; iron post stamped "2520"	2,518.930
T. 29 N., R. 47 E., standard quarter corner of sec. 31; iron section post stamped "2437"	2,435.515
T. 29 N., R. 47 E., standard corner of secs. 31 and 32; iron section post stamped "2477"	2,476.360
T. 29 R. N., 47 E., standard quarter corner of sec. 32; iron section post stamped "2451"	2,449.790
T. 29 N., R. 47 E., standard corner of secs. 32 and 33; iron section post stamped "2508"	2,507.317
T. 28 N., R. 47 E., quarter closing corner of sec. 2; iron section post stamped "2532"	2,530.661
T. 29 N., R. 47 E., standard corner of secs. 33 and 34; iron section post stamped "2482"	2,480.881
T. 29 N., R. 47 E., standard quarter corner of sec. 34; iron section post stamped "2516"	2,514.379
T. 28 N., Rs. 47 and 48 E., closing corner of; iron post stamped "2515"	2,514.302
T. 29 N., R. 47 E., standard quarter corner of sec. 35; iron section post stamped "2462"	2,460.868

	Feet.
T. 29 N., R. 47 E., standard corner of secs. 35 and 36; iron section post stamped "2424"	2,422.613
T. 29 N., R. 47 E., standard quarter corner of sec. 36; iron section post stamped "2400"	2,399.117
T. 29 N., Rs. 47 and 48 E., standard corner of; iron section post stamped "2338"	2,336.649
T. 29 N., R. 48 E., standard quarter corner of sec. 31; iron section post stamped "2307"	2,305.609
T. 29 N., R. 48 E., standard corner of secs. 31 and 32; iron section post stamped "2246"	2,244.599

Corner of Tps. 27 and 28 N., Rs. 46 and 47 E., north along guide meridian to seventh standard parallel.

Tps. 27 and 28 N., Rs. 46 and 47 E., on range line between Rs. 46 and 47 E., closing corner; iron post stamped "2073"	2,073.900
T. 28 N., R. 47 E., quarter closing corner of sec 31; iron section post	2,086.402
T. 28 N., R. 47 E., secs. 30 and 31, closing corner; iron section post	2,101.960
T. 28 N., R. 46 E., sec. 25, standard quarter corner; iron section post	2,122.620
T. 28 N., R. 47 E., secs. 19 and 30, closing corner; iron section post	2,129.212
T. 28 N., R. 46 E., sec. 24, standard quarter corner; iron section post	2,155.425
T. 28 N., R. 47 E., secs. 18 and 19, closing corner; iron section post	2,173.001
T. 28 N., R. 46 E., secs. 13 and 24, standard corner; iron section post	2,204.209
T. 28 N., R. 47 E., secs. 7 and 18, closing corner; iron section post	2,273.558
T. 28 N., R. 46 E., at northeast corner; iron post stamped "2496"	2,494.782

Sec. 5, T. 29 N., R. 48 E., west along township line to Rs. 46 and 47, thence south to southeast corner of T. 29 N., R. 46 E.

Tps. 29 and 30 N., R. 48 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "2589"	2,587.937
Tps. 29 and 30 N., R. 48 E., quarter corner between secs. 6 and 31; iron section post stamped "2611"	2,609.269
Tps. 29 and 30 N., Rs. 47 and 48 E., township corner; iron post stamped "2655"	2,653.804
Tps. 29 and 30 N., R. 47 E., quarter corner between secs. 1 and 36; iron section post stamped "2543"	2,541.620
Tps. 29 and 30 N., R. 47 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2470"	2,469.027
Tps. 29 and 30 N., R. 47 E., quarter corner between secs. 2 and 35; iron section post stamped "2433"	2,431.927
Tps. 29 and 30 N., R. 47 E., corner of secs. 2, 3, 34, and 35; iron section post stamped "2407"	2,406.010
Tps. 29 and 30 N., R. 47 E., quarter corner between secs. 3 and 34; iron section post stamped "2423"	2,421.633
Tps. 29 and 30 N., R. 47 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2477"	2,475.557
Tps. 29 and 30 N., R. 47 E., quarter corner between secs. 4 and 33; iron section post stamped "2624"	2,622.929
Tps. 29 and 30 N., R. 47 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2674"	2,672.781
Tps. 29 and 30 N., R. 47 E., quarter corner between secs. 5 and 32; iron section post stamped "2684"	2,682.592
Tps. 29 and 30 N., R. 47 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "2696"	2,694.723

	Feet.
Tps. 29 and 30 N., R. 47 E., quarter corner between secs. 6 and 31; iron section post stamped "2687"	2,685.837
Tps. 29 and 30 N., Rs. 47 and 46 E., closing township corner; iron post stamped "2712"	2,710.639
T. 29 N., R. 46 E., east quarter corner of sec. 1; iron section post stamped "2709"	2,707.294
T. 29 N., R. 46 E., corner of secs. 1 and 12; iron section post stamped "2681"	2,679.709
T. 29 N., R. 46 E., east quarter corner of sec. 12; iron section post stamped "2684"	2,682.717
T. 29 N., R. 46 E., northeast corner of sec. 13; iron section post stamped "2632"	2,630.781
T. 29 N., R. 46 E., east quarter corner of sec. 13; iron section post stamped "2605"	2,603.201
T. 29 N., R 46 E., witness corner to east corner of secs. 13 and 24; iron section post stamped "2552"	2,550.068
T. 29 N , R. 46 E., east quarter corner of sec. 24; iron section post stamped "2660"	2,658.260
T. 29 N., R 46 E., witness corner to corner of secs. 24 and 25; iron section post stamped "2673"	2,671.009
T. 29 N., R. 46 E., east quarter corner of sec. 25; iron section post stamped "2685"	2,683.393
T. 29 N., R. 46 E., northeast corner of sec. 36; iron section post stamped "2593"	2,591.441
T. 29 N., R. 46 E., east quarter corner of sec. 36; iron section post stamped "2547"	2,545.774
T. 29 N., R. 46 E., southeast corner of township; iron post stamped "2556"	2,554.447
Sec. 25, T. 32 N., R. 46 E., south and east to corner of Tps. 31 and 32 N., Rs. 47 and 46 E.	
T. 32 N., R. 46 E., quarter corner of sec. 36; iron section post stamped "2605"	(Moved.)
Tps. 31 and 32 N., Rs. 46 and 47 E., township corner; iron post stamped "2646 '	2,642.992[1]
Tps. 31 and 32 N., R. 47 E., closing township corner; iron post stamped "2666"	2,663.373[1]
Tps. 31 and 32 N., R. 47 E., quarter corner common to secs. 31 and 6; iron section post stamped "2783"	(Moved.)
Tps. 31 and 32 N., R. 47 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "2815"	(Moved.)
Tps. 31 and 32 N., R 47 E., quarter corner common to secs. 32 and 5; iron section post stamped "2855"	(Moved.)
Tps. 31 and 32 N., R. 47 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2845"	(Moved.)
Tps. 31 and 32 N., R. 47 E., quarter corner between secs. 4 and 33, R. 47 E.; iron section po t stamped "2851"	(Moved.)
Tps. 31 and 32 N., R. 47 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2849"	(Moved.)
Tps. 31 and 32 N., R. 47 E., quarter corner between secs. 3 and 34; iron section post stamped "2850"	(Moved.)
Tps. 31 and 32 N., R. 47 E., corner of secs. 2, 3, 34, and 35; iron section post stamped "2858"	(Moved.)

[1] Value given is probably wrong, as post was moved twice during 1909–1910 and no record was made in 1910.

	Feet.
Tps. 31 and 32 N., R. 47 E., quarter corner between secs. 2 and 35; iron section post stamped "2852"	(Moved.)
Tps. 31 and 32 N., R. 47 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2849"	(Moved.)
Tps. 31 and 32 N., R. 47 E., quarter corner of secs. 3 and 34; iron section post stamped "2850"	(Moved.)
Tps. 31 and 32 N., R. 47 E., corner secs. 2, 3, 34, and 35; iron section post stamped "2858"	(Moved.)
Tps. 31 and 32 N., R. 47 E., quarter corner secs. 2 and 35; iron section post stamped "2852"	(Moved.)
Tps. 31 and 32 N., R. 47 E., corner secs. 1, 2, 35, and 36; iron section post stamped "2849"	(Moved.)
Tps. 31 and 32 N., R. 47 E., quarter corner of secs. 1 and 36; iron section post stamped "2863"	(Moved.)
Tps. 31 and 32 N., Rs. 47 and 48 E., township corner; iron post stamped "2852"	2,851.336

Quarter corner of secs. 5 and 32, Tps. 31 and 32 N., R. 47 E., southwest and west 3 miles, thence south along range line and east along township line to sec. 32, Tps. 30 and 31 N., R. 48 E.

Tps. 31 and 32 N., R. 47 E., 0.5 mile southwest of quarter corner of secs. 5 and 32; wooden stake marked "2884"	2,883.0
Tps. 31 and 32 N., R. 47 E., 0.8 mile northeast of triangulation Station "Hole;" wooden stake marked "2890"	2,889.1
Triangulation Station "Hole;" iron post stamped "2898"	2,896.837
T. 31 N., R. 46 E., northeast corner of sec. 13; iron section post stamped "2881"	2,880.354
T. 31 N., R. 46 E., east quarter corner of sec. 13; iron section post stamped "2827"	2,825.567
T. 31 N., R. 46 E., northeast corner of sec. 24; iron section post stamped "2772"	2,770.524
T. 31 N., R. 46 E., east quarter corner of sec. 24; iron section post stamped "2760"	2,759.221
T. 31 N., R. 46 E., northeast corner of sec. 25; iron section post stamped "2750"	2,748.592
T. 31 N., R. 46 E., east quarter corner of sec. 25; iron section post stamped "2737"	2,735.981
T. 31 N., R. 46 E., northeast corner of sec. 36; iron section post stamped "2717"	2,715.818
T. 31 N., R. 46 E., east quarter corner of sec. 36; iron section post stamped "2701"	2,699.630
Tps. 30 and 31 N., R. 46 E., township corner; iron post stamped "2668"	2,667.335
Tps. 30 and 31 N., R. 47 E., closing township corner; iron post stamped "2671"	2,670.000
Tps. 30 and 31 N., R. 47 E., quarter corner between secs. 6 and 31; iron section post stamped "2727"	2,726.040
Tps. 30 and 31 N., R. 47 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "2735"	2,734.234
Tps. 30 and 31 N., R. 47 E., quarter corner secs. 5 and 32; iron section post stamped "2728"	2,727.280
Tps. 30 and 31 N., R. 47 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2733"	2,731.548
Tps. 30 and 31 N., R. 47 E., quarter corner between secs. 4 and 33; iron section post stamped "2717"	2,715.884

	Feet.
T. 30 and 31 N., R. 47 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2692"	2,691.369
Tps. 30 and 31 N., R. 47 E., quarter corner between secs. 3 and 34; iron section post stamped "2694"	2,693.660
Tps. 30 and 31 N., R. 47 E., corner of secs. 2, 3, 34, and 35; iron section post stamped "2702"	2,701.381
Tps. 30 and 31 N., R. 47 E., quarter corner between secs. 2 and 35; iron section post stamped "2694"	2,692.903
Tps. 30 and 31 N., R. 47 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2693"	2,691.990
Tps. 30 and 31 N., R. 47 E., quarter corner between secs. 1 and 36; iron section post stamped "2700"	2,698.574
Tps. 30 and 31 N., Rs. 47 and 48 E., township corner; iron post stamped "2703"	2,702.108
Tps. 30 and 31 N., R. 48 E., quarter corner between secs. 5 and 31; iron section post stamped "2630"	2,629.217
Tps. 30 and 31 N., R. 48 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "2635"	2,633.936

Nearly all the following bench marks, established by J. H. Wilke in 1910, were by single unchecked sights, and are therefore unreliable.

Sec. 28, T. 27 N., R. 48 E., northwest across Missouri River to point near Wolf Point.

	Feet.
T. 27 N., R. 48 E., about sec. 28, at roadside just west of badlands, inside corner of fence at southwest corner of field, one-half mile south of windmill; top of small rock marked "2105.4"	2,104.47
T. 27 N., R. 48 E., sec. 28, one-half mile south of Missouri River, at corner of fence one-half mile south of windmill at house at foot of hill; iron post stamped "2106.2"	2,105.119
T. 27 N., R. 48 E., sec. 28, at foot of hill where wagon road turns east to house at windmill; highest point of large sandstone, marked "2000.3"	1,999.38
T. 27 N., R. 48 E., sec. 20, 125 feet south of river bank at sharp point on shore of Missouri River; notch 2 feet up on small ash tree, marked "1990.1"	1,989.24
T. 27 N., R. 48 E., sec. 28; surface of water, Missouri River	1,967.4
T. 27 N., R. 48 E., sec. 20, just below bench where trail through woods comes into open; spike in 8-inch blazed cottonwood, marked "1981.7"	1,980.80
T. 27 N., R. 48 E., sec. 17, quarter corner 50 yards north of Indian's house; top of iron allotment post	1,987.41
Wolf Point, 4 miles southeast of, at quarter corner; top of Indian allotment post	1,988.57
Wolf Point, 665 feet west of railway bridge, 25 feet north of wagon road; top of nut (Missouri River Commission standard bench mark 98/2) [1]	1,989.741

Southeast corner of sec. 36, T. 31 N., R. 46 E., west along township line to corner of secs. 3, 4, 33, and 34, T. 31 N., R. 44 E.

Tps. 30 and 31 N., R. 46 E., township corner; iron post stamped "2668"	2,667.335
Tps. 30 and 31 N., R. 46 E., 5 feet south of quarter corner between secs. 1 and 36, small rock	2,719.42
Tps. 30 and 31 N., R. 46 E., 8 feet south of temporary position of corner of secs. 1, 2, 35, and 36; small rock	2,659.07
Tps. 30 and 31 N., R. 46 E., corner of secs. 2, 3, 34, and 35; iron section post.	2,745.285

[1] Cap on which nut is fastened has about 0.01 foot play vertically. Reading taken with cap depressed.

	Feet.
Tps. 30 and 31 N., R. 46 E., quarter corner between secs. 3 and 34; iron section post stamped "2731"	2,729.789
Tps. 30 and 31 N., R. 46 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2721"	2,720.242
Tps. 30 and 31 N., R. 46 E., quarter corner between secs. 4 and 33; iron section post stamped "2741"	2,739.905
Tps. 30 and 31 N., R. 46 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2734"	2,733.311
Tps. 30 and 31 N., R. 46 E., quarter corner between secs. 5 and 32; iron section post stamped "2727"	2,726.451
Tps. 30 and 31 N., R. 46 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "2693"	2,692.082
Tps. 30 and 31 N., R. 46 E., quarter corner between secs. 6 and 31; iron section post stamped "2748"	2,746.685
Tps. 30 and 31 N., Rs. 45 and 46 E., corner common to; iron post stamped "2788"	2,786.640
Tps. 30 and 31 N., R. 45 E., quarter corner between secs. 1 and 36; iron section post stamped "2782"	2,781.142
Tps. 30 and 31 N., R. 45 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2745"	2,743.849
Tps. 30 and 31 N., R. 45 E., quarter corner between secs. 2 and 35; iron section post stamped "2794"	2,792.627
Tps. 30 and 31 N., R. 45 E., corner of secs. 2, 3, 34, and 35; iron section post stamped "2734"	2,732.803
Tps. 30 and 31 N., R. 45 E., quarter corner between secs. 3 and 34; iron section post stamped "2757"	2,755.745
Tps. 30 and 31 N., R. 45 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2680"	2,678.580
Tps. 30 and 31 N., R. 45 E., corner of secs. 4, 5, 31, and 32; iron section post stamped "2835"	2,833.940
Tps. 30 and 31 N., R. 45 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "2820"	2,818.628
Tps. 30 and 31 N., Rs. 44 and 45 E., corner of iron post stamped "2802"	2,800.527
Tps. 30 and 31 N., R. 44 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2769"	2,769.778
Tps. 30 and 31 N., R. 44 E., corner of secs. 2, 3, 34, and 35; iron section post stamped "2857"	2,855.810
Tps. 30 and 31 N., R. 44 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2860"	2,859.399

POPLAR QUADRANGLE.

Missouri River Commission bench mark 104 2 via Poplar to Missouri River Commission bench mark 103 2.

Poplar, 750 feet north by 150 feet east of station; Missouri River Commission bench mark 104 2, iron post with cap:	
Top of tile under post	1,993.242
Top of cap	1,997.334
Poplar, in front of station, east end; top of north rail	1,965.9
Poplar, 0.9 mile west of, east end of steel truss bridge over Poplar River; top of north rail	1,970.3
T. 27 N., R. 30 E., corner of secs. 2, 3, 10, and 11, north of track; iron section post	1,970.382
Poplar, 2.4 miles west of, culvert over slough; top of rail	1,973.1

Missouri River Commission bench mark 103/2 north along section line 9 miles east of twelfth guide meridian to seventh standard parallel.

	Feet.
T. 27 N., R. 50 E., northeast corner of sec. 4; top of corner stone	1,971.697
T. 28 N., R. 50 E., between secs. 33 and 34; quarter corner stone	1,980.191
T. 28 N., R. 50 E., between secs. 27 and 28; top of quarter corner stone	2,006.353
T. 28 N., R. 50 E., southeast corner sec. 21; corner stone	2,087.928
T. 28 N., R. 50 E., secs. 21 and 22; quarter corner stone	2,116.596
T. 28 N., R. 50 E., southeast corner of sec. 16; corner stone	2,137.133
T. 28 N., R. 50 E., secs. 15 and 16; quarter section stone	2,151.533
T. 28 N., R. 50 E., near corner of secs. 9, 10, 15, and 16; rock	2,170.135
T. 28 N., R. 50 E., secs. 9 and 10; quarter corner stone	2,171.429
T. 28 N., R. 50 E., secs. 3, 4, 9, and 10; corner stone	2,180.660
T. 28 N., R. 50 E., secs. 3 and 4; quarter corner stone	2,182.756
T. 28 N., R. 50 E., secs. 3 and 4, closing corner; iron section post stamped "2201"	2,200.503
T. 29 N., R. 50 E., secs. 31 and 32, standard corner; iron section post stamped "2195"	2,193.054
T. 28 N., R. 50 E., quarter corner on north side of sec. 3; iron section post	2,193.442

Sec. 32, T. 29 N., R. 48 E., east and south to Missouri River Commission bench mark 105/2.

T. 29 N., R. 48 E., standard quarter corner of sec. 32; stone marked "2202"	2,200.81
T. 29 N., R. 48 E., standard corner of secs. 32 and 33; stone marked "2261"	2,260.09
T. 29 N., R. 48 E., standard quarter corner of sec. 33; stone marked "2308"	2,306.68
T. 29 N., R. 48 E., standard corner of secs. 33 and 34; stone marked "2373"	2,371.62
T. 29 N., R. 48 E., standard quarter corner of sec. 34; stone marked "2340"	2,339.07
T. 28 N., R. 48 and 49 E., closing corner of; iron post stamped "2354"	2,352.486
T. 29 N., R. 48 E., standard quarter corner of sec. 35; stone marked "2339"	2,337.42
T. 29 N., R. 48 E., standard corner of secs. 35 and 36; stone marked "2353"	2,351.20
T. 29 N., R. 48 E., standard quarter corner of sec. 36; stone marked "2294"	2,292.93
T. 29 N., R. 48 and 49 E., standard quarter corner of; iron post stamped "2273"	2,271.148
T. 29 N., R. 49 E., standard quarter corner of sec. 31; stone marked "2211"	2,209.26
T. 29 N., R. 49 E., standard corner of secs. 31 and 32; stone marked "2244"	2,242.77
T. 29 N., R. 49 E., standard quarter corner of sec. 32; stone marked "2245"	2,243.52
T. 29 N., R. 49 E., standard corner of secs. 32 and 33; stone marked "2249"	2,247.95
T. 29 N., R. 49 E., standard quarter corner of sec. 33; stone marked "2241"	2,239.26
T. 29 N., R. 49 E., standard corner of secs. 33 and 34; stone marked "2229"	2,227.82
T. 29 N., R. 49 E., standard quarter corner of sec. 34; stone marked "2210"	2,208.61
T. 28 N., Rs. 49 and 50 E., closing corner of; iron post stamped "2150"	2,148.430
T. 29 N., R. 49 E., standard quarter corner of sec. 35; stone marked "2211"	2,209.21
T. 29 N., R. 49 E., standard corner of secs. 35 and 36; iron section post stamped "2227"	2,225.432
T. 29 N., R. 49 E., standard quarter corner of sec. 36; iron section post stamped "2222"	2,220.731
T. 29 N., Rs. 49 and 50 E., standard corner of; iron post stamped "2222"	2,220.130
T. 29 N., R. 50 E., standard quarter corner of sec. 31; iron section post stamped "2213"	2,213.905
T. 29 N., R. 50 E., standard corner of secs. 31 and 32; iron section post stamped "2195"	2,193.054
T. 29 N., R. 50 E., standard quarter corner of sec. 32; iron section post stamped "2196"	2,194.834
T. 29 N., R. 50 E., standard corner of secs. 32 and 33; iron section post stamped "2182"	2,180.624

	Feet.
T. 29 N., R. 50 E., standard quarter corner of sec. 33; iron section post stamped "2175"	2,173.275
T. 29 N., R. 50 E., standard corner of secs. 33 and 34; iron section post stamped "2168"	2,166.877
T. 29 N., R. 50 E., standard quarter corner of sec. 34; iron section post stamped "2159"	2,157.799
T. 28 N., Rs. 50 and 51 E., closing corner of township; iron post stamped "2089"	2,087.930
T. 29 N., R. 50 E., standard quarter corner of sec. 35; iron section post stamped "2213"	2,211.023
T. 29 N., R. 50 E., standard corner of secs. 35 and 36; iron section post stamped "2136"	2,134.319
T. 29 N., R. 50 E., standard quarter corner of sec. 36; iron section post stamped "2044"	2,042.762
T. 29 N., Rs. 50 and 51 E., standard corner of; iron post stamped "2000"	1,998.904
T. 29 N., R. 51 E., standard quarter corner of sec. 31; iron section post stamped "2005"	2,003.067
T. 29 N., R. 51 E., standard corner of secs. 31 and 32; iron section post stamped "2058"	2,056.164
T. 29 N., R. 51 E., standard quarter corner of sec. 32; iron section post stamped "2079"	2,077.881
T. 29 N., R. 51 E., standard corner of secs. 32 and 33; iron section post stamped "2122"	2,120.446
T. 29 N., R. 51 E., standard quarter corner of sec. 33; iron section post stamped "2129"	2,127.894
T. 29 N., R. 51 E., standard corner of secs. 33 and 34; iron section post stamped "2206"	2,204.721
T. 29 N., R. 51 E., standard quarter corner of sec. 34; iron section post stamped "2196"	2,194.450
T. 28 N., Rs. 51 and 52 E., closing corner of; iron post stamped "2171"	2,169.048
T. 29 N., R. 51 E., standard quarter corner of sec. 35; iron section post	2,126.222
T. 29 N., R. 51 E., standard corner of secs. 35 and 36; iron section post	2,068.058
T. 28 N., R. 51 E., standard quarter corner between secs. 3 and 4; iron section post stamped "2054"	2,052.278
T. 28 N., R. 51 E., corner of secs. 3, 4, 9, and 10; iron section post stamped "2062"	2,060.432
T. 28 N., R. 51 E., quarter corner between secs. 9 and 10; iron section post stamped "2057"	2,055.615
T. 28 N., R. 51 E., corner of secs. 9, 10, 15, and 16; iron section post stamped "2059"	2,057.069
T. 28 N., R. 51 E., quarter corner between secs. 15 and 16; iron section post stamped "2076"	2,073.995
T. 28 N., R. 51 E., corner of secs. 15, 16, 21, and 22; iron section post stamped "2069"	2,067.029
T. 28 N., R. 51 E., quarter corner between secs. 21 and 22; iron section post stamped "2084"	2,082.623
T. 28 N., R. 51 E., corner of secs. 21, 22, 27, and 28; iron section post stamped "2090"	2,088.795
T. 28 N., R. 51 E., quarter corner between secs. 27 and 28; iron section post stamped "2099"	2,097.139
T. 28 N., R. 51 E., corner of secs. 27, 28, 33, and 34; iron section post stamped "2103"	2,101.151
T. 28 N., R. 51 E., quarter corner between secs. 33 and 34; iron section post stamped "2113"	2,111.005

	Feet.
Tps. 27 and 28 N., R. 51 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2086"	2,084.422
T. 27 N., R. 51 E., quarter corner between secs. 3 and 4; iron section post stamped "2047"	2,045.178
T. 27 N., R. 51 E., corner of secs. 3, 4, 9, and 10; iron section post stamped "1974"	1,972.912
Poplar, about 2.5 miles east of station, on east bank of Missouri River, 400 feet south of Great Northern Ry. track; Missouri River Commission bench mark 105/2, plotted on chart 68 of Missouri River Commission; tile underground	1,960.504

Missouri River Commission bench mark 104/2 northwest along Great Northern Ry. to Missouri River Commission bench mark 103/2, thence north along section line to sec. 32, T. 29 N., R. 50 E.

Poplar, 750 feet north by 150 feet east of Great Northern Ry. station, on east bank; Missouri River Commission bench mark 104/2	1,993.242
Poplar, in front of station; top of east end of north rail of main track	1,965.9
Poplar, 0.8 mile west of, steel bridge over Poplar River, at third joint west of east end of east steel truss; top of north rail	1,970.2
Poplar 0.8 mile west of Great Northern Ry. bench mark; spike in telephone pole on north side of track near east end of bridge	1,962.46
Poplar, 1 mile west of, at road crossing; top of north rail	1,968.2
Poplar, 1.8 miles east of, north side of track, Great Northern Ry. bench mark; spike in telephone pole, marked "1968.57"	1,974.57
T. 27 N., R. 50 E., corner of secs. 2, 3, 10, and 11, north of track; iron section post	1,970.382
Poplar, 2.7 miles west of, at center of road crossing; top of north rail	1,973.0
Poplar Creek, 2.25 miles west of Great Northern Ry. bridge over, on east bank of Missouri River; Missouri River Commission bench mark 103/2, 300 feet south of track and 650 feet from edge of timber; tile underground	1,964.237
T. 27 N., R. 50 E., quarter section corner between secs. 3 and 4; top of stone	1,966.95
Tps. 27 and 28 N., R. 50 E., corner of secs. 3, 4, 33, and 34; top of stone	1,971.70
T. 28 N., R. 50 E., quarter section corner between secs. 33 and 34; top of stone	1,980.19
T. 28 N., R. 50 E., quarter section corner between secs. 27 and 28; top of stone	2,006.35
T. 28 N., R. 50 E., corner of secs. 21, 22, 27, and 28; top of stone	2,087.93
T. 28 N., R. 50 E., quarter section corner, between secs. 21 and 22; top of stone	2,116.60
T. 28 N., R. 50 E., corner of secs. 15, 16, 21, and 22; top of stone	2,137.07
T. 28 N., R. 50 E., quarter corner between secs. 15 and 16; top of stone	2,151.53
T. 28 N., R. 50 E., near corner of secs. 9, 10, 15, and 16; rock	2,170.13
T. 28 N., R. 50 E., quarter corner between secs. 9 and 10; top of stone	2,171.43
T. 28 N., R. 50 E., corner of secs. 3, 4, 9, and 10; top of stone	2,180.66
T. 28 N., R. 50 E., quarter section corner between secs. 3 and 4; top of stone	2,182.76
T. 28 N., R. 50 E., closing corner of secs. 3 and 4; iron section post stamped "2202"	2,200.503
T. 29 N., R. 50 E., standard corner of secs. 31 and 32; iron section post stamped "2195"	2,193.054
T. 28 N., R. 50 E., closing quarter corner of sec. 3; iron section post	2,193.442

T. 28 N., Rs. 51 and 52 E., east along standard parallel, thence north along range line to corner of Tps. 29 and 30 N., Rs. 51 and 52 E.

	Feet.
T. 28 N., Rs. 51 and 52 E., closing corner of; iron post stamped "2171"	2,169.048
T. 29 N., R. 51 E., standard corner of secs. 34 and 35; iron section post stamped "2168"	2,166.605
T. 28 N., R. 52 E., witness corner to closing corner of secs. 5 and 6; iron section post stamped "2071"	2,069.814
T. 29 N., R. 51 E., witness corner to standard corner of secs. 35 and 36; iron section post stamped "2071"	2,069.639
T. 29 N., R. 51 E., sec. 36; standard quarter section stone	2,066.89
T. 29 N., Rs. 51 and 52 E., witness corner to standard township corner; iron post stamped "2069"	2,067.914
T. 29 N., R. 51 E., and 52 E., standard township corner; iron post stamped "2069"	2,067.914
T. 29 N., Rs. 51 and 52 E., quarter corner between secs. 36 and 31; iron section post	2,063.048
T. 29 N., Rs. 51 and 52 E., corner of secs. 25, 30, 31, and 36; iron section post	2,065.440
T. 29 N., Rs. 51 and 52 E., quarter corner between secs. 25 and 30; iron section post	2,061.059
T. 29 N., Rs. 51 and 52 E., corner of secs. 19, 24, 25, and 30; iron section post	2,091.346
T. 29 N., Rs. 51 and 52 E., quarter corner between secs. 24 and 19; iron section post	2,136.627
T. 29 N., Rs. 51 and 52 E., corner of secs. 13, 18, 24, and 19; iron section post	2,162.129
T. 29 N., Rs. 51 and 52 E., quarter corner between secs. 13 and 18; iron section post	2,180.468
T. 29 N., Rs. 51 and 52 E., corner of secs. 12, 13, 7, and 18; iron section post	2,199.450
T. 29 N., Rs. 51 and 52 E., quarter corner between secs. 7 and 12; iron section post	2,238.543
T. 29 N., Rs. 51 and 52 E., corner of secs. 1, 12, 6, and 7; iron section post	2,256.354
T. 29 N., Rs. 51 and 52 E., quarter corner between secs. 1 and 6; iron section post	2,283.755
Tps. 29 and 30, Rs. 51 and 52 E., township corner; iron post stamped "2255"	2,254.270

Corner of Tps. 28 and 29 N., Rs. 50 and 51 E., north along range line to sec. 25, T. 32 N., R. 50 E.

T. 29 N., R. 50 E., sec. 36, 66.6 feet (1.01 chains) west of standard township corner, which falls in Poplar River, set as witness corner on standard parallel; iron post stamped "2000"	1,998.904
T. 29 N., Rs. 50 and 51 E., secs. 36 and 31, 66 feet (1 chain) north of true point for this corner, set as witness corner of 12th guide meridian east; iron post stamped "2001"	2,000.216
T. 29 N., Rs. 50 and 51 E., set as witness corner on 7th standard parallel, 66 feet (1 chain) west of true point for the corner as given in first description of this line; stone	1,998.856
T. 29 N., Rs. 50 and 51 E., at quarter corner between secs. 36 and 31; iron section post stamped "2001"	1,999.799
T. 29 N., Rs. 50 and 51 E., corner of secs. 31, 30, 25, and 36; iron section post stamped "2036"	2,034.855
T. 29 N., Rs. 50 and 51 E., quarter corner between secs. 25 and 30; iron section post stamped "2057"	2,055.138

	Feet.
T. 29 N., Rs. 50 and 51 E., corner of secs. 24, 25, 19, and 30; iron section post stamped "2089"	2,087.828
T. 29 N., Rs. 50 and 51 E., quarter corner between secs. 19 and 24; iron section post stamped "2135"	2,134.130
T. 29 N., Rs. 50 and 51 E., corner of secs. 18, 19, 13, and 24; iron section post stamped "2162"	2,161.304
T. 29 N., Rs. 50 and 51 E., quarter corner between secs. 13 and 18; iron section post stamped "2145"	2,143.691
T. 29 N., Rs. 50 and 51 E., corner of secs. 12, 13, 7, and 18; iron section post stamped "2191"	2,189.486
T. 27 N., Rs. 50 and 51 E., quarter corner between secs. 12 and 7; iron section post stamped "2230"	2,228.898
T. 29 N., Rs. 50 and 51 E., corner of secs. 6, 7, 1, and 12; iron section post stamped "2255"	2,254.103
T. 29 N., Rs. 50 and 51 E., quarter corner between secs. 1 and 6; iron section post stamped "2332"	2,331.360
Tps. 29 and 30 N., Rs. 50 and 51 E., township corner; iron post stamped "2474"	2,472.614
T. 29 N., R. 51 E., NW. ¼ sec. 6, "Polaris" triangulation station; located by short circuit from township corner (2,472.614) to triangulation station and return; iron post stamped "2506"	2,505.371
T. 30 N., Rs. 50 and 51 E., quarter corner between secs. 31 and 36; iron section post stamped "2398"	2,396.660
T. 30 N., Rs. 50 and 51 E., corner of secs. 30, 31, 25, and 36; iron section post stamped "2281"	2,279.934
T. 30 N., Rs. 50 and 51 E., quarter corner between secs. 25 and 30; iron section post stamped "2361"	2,359.647
T. 30 N., Rs. 50 and 51 E., corner of secs. 24, 25, 19, and 30; iron section post stamped "2227"	2,226.220
T. 30 N., Rs. 50 and 51 E., quarter corner between secs. 19 and 24; iron section post stamped "2238"	2,236.961
T. 30 N., Rs. 50 and 51 E., sixteenth corner, north half of secs. 19 and 24; stone painted 2163	2,161.722
T. 30 N., Rs. 50 and 51 E., corner of secs. 18, 19, 13, and 24; iron section post stamped "2146"	2,144.612
T. 30 N., Rs. 50 and 51 E., south sixteenth corner between secs. 13 and 18; stone marked "2124"	2,122.57
T. 30 N., Rs. 50 and 51 E., quarter corner between secs. 13 and 18; iron section post stamped "2112"	2,111.071
T. 30 N., Rs. 50 and 51 E., north sixteenth corner between secs. 13 and 18; stone marked "2105"	2,104.29
T. 30 N., Rs. 12, 13, 7, and 18, corner of; iron section post stamped "2091"	2,089.645
T. 30 N., Rs. 50 and 51 E., south sixteenth corner between secs. 7 and 12; stone marked "2088"	2,086.66
T. 30 N., Rs. 50 and 51 E., quarter corner between secs. 7 and 12; iron section post stamped "2092"	2,090.418
T. 30 N., Rs. 50 and 51 E., north sixteenth corner between secs. 7 and 12; stone marked "2088"	2,086.486
T. 30 N., Rs. 50 and 51 E., corner of secs. 6, 7, 1, and 12; iron section post stamped "2103"	2,101.632
T. 30 N., Rs. 50 and 51 E., south sixteenth corner between secs. 1 and 6; stone marked "2114"	2,112.64
T. 30 N., Rs. 50 and 51 E., quarter corner between secs. 1 and 6; iron section post stamped "2121"	2,119.774

	Feet.
Tps. 30 and 31 N., Rs. 50 and 51 E., standard township corner; iron post stamped "2150"	2,148.594
T. 31 N., Rs. 50 and 51 E., quarter corner between secs. 31 and 36; iron section post stamped "2180"	2,178.785
T. 31 N., Rs. 50 and 51 E., corner of secs. 30, 31, 25, and 36; iron section post stamped "2218"	2,217.015
T. 31 N., Rs. 50 and 51 E., quarter corner between secs. 30 and 35; iron section post stamped "2255"	2,253.977
T. 31 N., Rs. 50 and 51 E., corner of secs. 24, 25, 19, and 30; iron section post stamped "2285"	2,284.381
T. 31 N., Rs. 50 and 51 E., quarter corner between secs. 19 and 24; iron section post stamped "2318"	2,316.695
T. 31 N., Rs. 50 and 51 E., corner of secs. 18, 19, 13, and 24; iron section post stamped "2365"	2,364.401
T. 31 N., Rs. 50 and 51 E., quarter corner between secs. 13 and 18; iron section post stamped "2397"	2,396.487
T. 31 N., Rs. 50 and 51 E., corner of secs. 12, 13, 7, and 18; iron section post stamped "2407"	2,406.330
T. 31 N., Rs. 50 and 51 E., quarter corner between secs. 7 and 12; iron section post stamped "2448"	2,447.357
T. 31 N., Rs. 50 and 51 E., corner of secs. 6, 7, 1, and 12; iron section post stamped "2507"	2,505.754
T. 31 N., Rs. 50 and 51 E., quarter corner between secs. 1 and 6; iron section post stamped "2602"	2,600.770
Tps. 31 and 32 N., Rs. 50 and 51 E., township corner; iron post stamped "2670"	2,669.016
T. 32 N., Rs. 50 and 51 E., quarter corner between secs. 31 and 36; iron section post stamped "2652"	2,651.251
T. 32 N., Rs. 50 and 51 E., corner of secs. 30, 31, 25, and 36; iron section post stamped "2654"	2,653.170

Corner of Tps. 29 and 30 N., Rs. 50 and 51 E., west along township line to sec. 31, T. 30 N., R. 48 E.

Tps. 29 and 30 N., R. 50 E., quarter corner between secs. 1 and 36; iron section post stamped "2452"	2,450.839
Tps. 29 and 30 N., R. 50 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2415"	2,414.143
Tps. 29 and 30 N., R. 50 E., quarter corner between secs. 2 and 35; iron section post stamped "2457"	2,456.180
Tps. 29 and 30 N., R. 50 E., corner of secs. 34, 3, 35, and 2; iron section post stamped "2462"	2,461.107
Tps. 29 and 30 N., R. 50 E., quarter corner between secs. 3 and 34; iron section post stamped "2386"	2,384.900
Tps. 29 and 30 N., R. 50 E., corner of secs. 33, 4, 34, and 3; iron section post stamped "2418"	2,416.879
Tps. 29 and 30 N., R. 50 E., quarter corner between secs. 4 and 33; iron section post stamped "2413"	2,412.203
Tps. 29 and 30 N., R. 50 E., corner of secs. 32, 4, 33, and 3; iron section post stamped "2406"	2,404.969
Tps. 29 and 30 N., R. 50 E., quarter corner between secs. 3 and 32; iron section post stamped "2421"	2,419.693
Tps. 29 and 30 N., R. 50 E., corner of secs. 31, 5, 32, and 4; iron section post stamped "2568"	2,567.119

	Feet.
Tps. 29 and 30 N., R. 50 E., quarter corner between secs. 5 and 31; iron section post stamped "2655"	2,653.705
Tps. 29 and 30 N., Rs. 49 and 50 E., township corner; iron post stamped "2553"	2,552.094
Tps. 29 and 30 N., R. 49 E., quarter corner between secs. 1 and 36; iron section post stamped "2516"	2,515.091
Tps. 29 and 30 N., R. 49 E., corner of secs. 35, 2, 36, and 1; iron section post stamped "2495"	2,493.360
Tps. 29 and 30 N., R. 49 E., quarter corner between secs. 2 and 35; iron section post stamped "2570"	2,568.850
Tps. 29 and 30 N., R. 49 E., corner of secs. 34, 3, 35, and 2; iron section post stamped "2529"	2,527.787
Tps. 29 and 30 N., R. 49 E., quarter corner between secs. 3 and 34; iron section post stamped "2522"	2,520.357
Tps. 29 and 30 N., R. 49 E., corner of secs. 33, 4, 24, and 3; iron section post stamped "2444"	2,442.922
Tps. 29 and 30 N., R. 49 E., quarter corner between secs. 33 and 4; iron section post stamped "2406"	2,405.067
Tps. 29 and 30 N., R. 49 E., corner of secs. 32, 5, 33, and 4; iron section post stamped "2357"	2,355.491
Tps. 29 and 30 N., R. 49 E., quarter corner between secs. 32 and 5; iron section post stamped "2367"	2,365.718
Tps. 29 and 30 N., R. 49 E., corner of secs. 31, 32, 6, and 5; iron section post stamped "2346"	2,344.753
Tps. 29 and 30 N., R. 49 E., quarter corner between secs. 6 and 31; iron section post stamped "2436"	2,434.539
Tps. 29 and 30 N., Rs. 48 and 49 E., township corner; iron post stamped "2492"	2,490.915
Tps. 29 and 30 N., R. 48 E., quarter corner between secs. 1 and 36; iron section post stamped "2596"	2,594.614
Tps. 29 and 30 N., R. 48 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2654"	2,652.815
Tps. 29 and 30 N., R. 48 E., quarter corner between secs. 2 and 35; iron section post stamped "2665"	2,663.948
Tps. 29 and 30 N., R. 48 E., corner of secs. 2, 3, 34, and 35; iron section post stamped "2640"	2,638.862
Tps. 29 and 30 N., R. 48 E., quarter corner between secs. 3 and 34; iron section post stamped "2611"	2,609.624
Tps. 29 and 30 N., R. 48 E., corner of secs. 33, 34, 3, and 4; iron section post stamped "2529"	2,527.497
Tps. 29 and 30 N., R. 48 E., quarter corner between secs. 33 and 4; iron section post stamped "2502"	2,500.264
Tps. 29 and 30 N., R. 48 E., corner of secs. 32, 33, 4, and 5; iron section post stamped "2590"	2,588.504
Tps. 29 and 30 N., R. 48 E., quarter corner between secs. 5 and 32; iron section post stamped "2604"	2,602.380

Corner of Tps. 30 and 31 N., Rs. 51 and 52 E., west along township line to sec. 31, T. 31 N., R. 48 E.

Tps. 30 and 31 N., Rs. 51 and 52 E., standard corner; iron post stamped "2400"	2,399.142
Tps. 30 and 31 N., R. 51 E., quarter corner between secs. 1 and 36; iron section post stamped "2362"	2,360.590

	Feet.
Tps. 30 and 31 N., R. 51 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2353"	2,352.055
Tps. 30 and 31 N., R. 51 E., quarter corner between secs. 2 and 35; iron section post stamped "2334"	2,333.188
Tps. 30 and 31 N., R. 51 E., corner of secs. 2, 3, 34, and 35; iron section post stamped "2321"	2,320.070
Tps. 30 and 31 N., R. 51 E., quarter corner between secs. 3 and 34; iron section post stamped "2306"	2,304.634
Tps. 30 and 31 N., R. 51 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2260"	2,258.654
Tps. 30 and 31 N., R. 51 E., quarter corner between secs. 4 and 33; iron section post stamped "2236"	2,234.747
Tps. 30 and 31 N., R. 51 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2240"	2,239.355
Tps. 30 and 31 N., R. 51 E., quarter corner between secs. 5 and 32; iron section post stamped "2240"	2,238.845
Tps. 30 and 31 N., R. 51 E., corner of secs. 5, 6, 31, and 32, iron section post stamped "2219"	2,217.560
Tps. 30 and 31 N., R. 51 E., quarter corner between secs. 6 and 31; iron section post stamped "2190"	2,188.615
Tps. 30 and 31 N., Rs. 50 and 51 E., standard township corner; iron post stamped "2150"	2,148.594
Tps. 30 and 31 N., R. 50 E., quarter corner between secs. 1 and 36; iron section post stamped "2175"	2,174.366
Tps. 30 and 31 N., R. 50 E., sixteenth corner W. ½ secs. 1 and 36; stone marked "2163"	2,161.947
Tps. 30 and 31 N., R. 50 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2101"	2,099.776
Tps. 30 and 31 N., R. 50 E., east sixteenth corner between secs. 2 and 35; stone marked "2102"	2,101.01
Tps. 30 and 31 N., R. 50 E., quarter corner between secs. 2 and 35; iron section post stamped "2106"	2,104.998
Tps. 30 and 31 N., R. 50 E., west sixteenth corner between secs. 2 and 35; stone marked "2110"	2,109.054
Tps. 30 and 31 N., R. 50 E., corner of secs. 2, 3, 34, and 35; iron section post stamped "2112"	2,111.383
Tps. 30 and 31 N., R. 50 E., east sixteenth corner between secs. 3 and 34; stone marked "2115"	2,113.98
Tps. 30 and 31 N., R. 50 E., quarter corner between secs. 3 and 34; iron section post stamped "2119"	2,117.702
Tps. 30 and 31 N., R. 50 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2200"	2,198.730
Tps. 30 and 31 N., R. 50 E., quarter corner between secs. 4 and 33; iron section post stamped "2167"	2,166.322
Tps. 30 and 31 N., R. 50 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2220"	2,218.796
Tps. 30 and 31 N., R. 50 E., quarter corner between secs. 5 and 32; iron section post stamped "2317"	2,316.259
Tps. 30 and 31 N., R. 50 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "2326"	2,325.205
Tps. 30 and 31 N., R. 50 E., quarter corner between secs. 31 and 6; iron section post stamped "2331"	2,329.751
Tps. 30 and 31 N., Rs. 49 and 50 E., standard township corner; iron post stamped "2364"	2,362.465

	Feet.
Tps. 30 and 31 N., R. 49 E., quarter corner between secs. 1 and 36; iron section post stamped "2438"	2,436.540
Tps. 30 and 31 N., R. 49 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2526"	2,525.037
Tps. 30 and 31 N., R. 49 E., quarter corner between secs. 3 and 34; iron section post stamped "2680"	2,678.801
Tps. 30 and 31 N., R. 49 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2677"	2,675.992
Tps. 30 and 31 N., R. 49 E., quarter corner between secs. 4 and 33; iron section post stamped "2678"	2,676.975
Tps. 30 and 31 N., R. 49 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2669"	2,667.844
Tps. 30 and 31 N., R. 49 E., quarter corner between secs. 32 and 5; iron section post stamped "2704"	2,702.983
Tps. 30 and 31 N., R. 49 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "2707"	2,705.555
Tps. 30 and 31 N., R. 49 E., quarter corner between secs. 6 and 31; iron section post stamped "2719"	2,718.341
Tps. 30 and 31 N., R. 48 and 49 E., township corner; iron post stamped "2687"	2,685.772
Tps. 30 and 31 N., R. 48 E., quarter corner between secs. 1 and 36; iron section post stamped "2674"	2,673.384
Tps. 30 and 31 N., R. 48 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2678"	2,676.595
Tps. 30 and 31 N., R. 48 E., quarter corner between secs. 35 and 2; iron section post stamped "2709"	2,708.193
Tps. 30 and 31 N., R. 48 E., corner secs. 34, 35, 3, and 2; iron section post stamped "2651"	2,650.031
Tps. 30 and 31 N., R. 48 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2687"	2,685.644
Tps. 30 and 31 N., R. 48 E., quarter corner between secs. 4 and 33; iron section post stamped "2614"	2,612.524
Tps. 30 and 31 N., R. 48 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2606"	2,604.830
Tps. 30 and 31 N., R. 48 E., near quarter corner between secs. 5 and 32; wooden stake marked "2631"	2,629.40

Corner of Tps. 31 and 32 N., Rs. 51 and 52 E., west along township line to corner of Tps. 31 and 32 N., Rs. 49 and 50 E., thence northwest 1 mile.

Tps. 31 and 32 N., Rs. 51 and 52, township corner; iron post stamped "2596"	2,594.967
Tps. 31 and 32 N., R. 51 E., quarter corner between secs. 1 and 36; iron section post stamped "2621"	2,619.424
Tps. 31 and 32 N., R. 51 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2627"	2,625.496
Tps. 31 and 32 N., R. 51 E., quarter corner between secs. 2 and 35; iron section post stamped "2633"	2,631.075
Tps. 31 and 32 N., R. 51 E., corner of secs. 2, 3, 34, and 35; iron section post stamped "2620"	2,618.595
Tps. 31 and 32 N., R. 51 E., quarter corner between secs. 3 and 34; iron section post stamped "2649"	2,647.502
Tps. 31 and 32 N., R. 51 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2650"	2,648.304

	Feet.
Tps. 30 and 31 N., R. 51 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2353"	2,352.0
Tps. 30 and 31 N., R. 51 E., quarter corner between secs. 2 and 35; iron section post stamped "2334"	2,333.1
Tps. 30 and 31 N., R. 51 E., corner of secs. 2, 3, 34, and 35; iron section post stamped "2321"	2,320.0
Tps. 30 and 31 N., R. 51 E., quarter corner between secs. 3 and 34; iron section post stamped "2306"	2,304.6
Tps. 30 and 31 N., R. 51 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2260"	2,258.6
Tps. 30 and 31 N., R. 51 E., quarter corner between secs. 4 and 33; iron section post stamped "2236"	2,234.7
Tps. 30 and 31 N., R. 51 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2240"	2,239.3
Tps. 30 and 31 N., R. 51 E., quarter corner between secs. 5 and 32; iron section post stamped "2240"	2,238.8
Tps. 30 and 31 N., R. 51 E., corner of secs. 5, 6, 31, and 32, iron section post stamped "2219"	2,217.5
Tps. 30 and 31 N., R. 51 E., quarter corner between secs. 6 and 31; iron section post stamped "2190"	2,188.6
Tps. 30 and 31 N., Rs. 50 and 51 E., standard township corner; iron post stamped "2150"	2,148.5
Tps. 30 and 31 N., R. 50 E., quarter corner between secs. 1 and 36; iron section post stamped "2175"	2,174.3
Tps. 30 and 31 N., R. 50 E., sixteenth corner W. ½ secs. 1 and 36; stone marked "2163"	2,161.9
Tps. 30 and 31 N., R. 50 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2101"	2,099.77
Tps. 30 and 31 N., R. 50 E., east sixteenth corner between secs. 2 and 35; stone marked "2102"	2,101.01
Tps. 30 and 31 N., R. 50 E., quarter corner between secs. 2 and 35; iron section post stamped "2106"	2,104.99
Tps. 30 and 31 N., R. 50 E., west sixteenth corner between secs. 2 and 35; stone marked "2110"	2,109.05
Tps. 30 and 31 N., R. 50 E., corner of secs. 2, 3, 34, and 35; iron section post stamped "2112"	2,111.38
Tps. 30 and 31 N., R. 50 E., east sixteenth corner between secs. 3 and 34; stone marked "2115"	2,113.98
Tps. 30 and 31 N., R. 50 E., quarter corner between secs. 3 and 34; iron section post stamped "2119"	2,117.70
Tps. 30 and 31 N., R. 50 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2200"	2,198.73
Tps. 30 and 31 N., R. 50 E., quarter corner between secs. 4 and 33; iron section post stamped "2167"	2,166.32
Tps. 30 and 31 N., R. 50 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2220"	2,218.79
Tps. 30 and 31 N., R. 50 E., quarter corner between secs. 5 and 32; iron section post stamped "2317"	2,316.25
Tps. 30 and 31 N., R. 50 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "2326"	2,325.20
Tps. 30 and 31 N., R. 50 E., quarter corner between secs. 31 and 6; iron section post stamped "2331"	2,329.75
Tps. 30 and 31 N., Rs. 49 and 50 E., standard township corner; iron post stamped "2364"	2,362.46

	Feet.
Tps. 30 and 31 N., R. 49 E., quarter corner between secs. 1 and 36; iron section post stamped "2438"	2,436.540
Tps. 30 and 31 N., R. 49 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2526"	2,525.037
Tps. 30 and 31 N., R. 49 E., quarter corner between secs. 3 and 34; iron section post stamped "2680"	2,678.801
Tps. 30 and 31 N., R. 49 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2677"	2,675.992
Tps. 30 and 31 N., R. 49 E., quarter corner between secs. 4 and 33; iron section post stamped "2678"	2,676.975
Tps. 30 and 31 N., R. 49 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2669"	2,667.844
Tps. 30 and 31 N., R. 49 E., quarter corner between secs. 32 and 5; iron section post stamped "2704"	2,702.983
Tps. 30 and 31 N., R. 49 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "2707"	2,705.555
Tps. 30 and 31 N., R. 49 E., quarter corner between secs. 6 and 31; iron section post stamped "2719"	2,718.341
Tps. 30 and 31 N., R. 48 and 49 E., township corner; iron post stamped "2687"	2,685.772
Tps. 30 and 31 N., R. 48 E., quarter corner between secs. 1 and 36; iron section post stamped "2674"	2,673.384
Tps. 30 and 31 N., R. 48 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2678"	2,676.595
Tps. 30 and 31 N., R. 48 E., quarter corner between secs. 35 and 2; iron section post stamped "2709"	2,708.193
Tps. 30 and 31 N., R. 48 E., corner secs. 34, 35, 3, and 2; iron section post stamped "2651"	2,650.031
Tps. 30 and 31 N., R. 48 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2687"	2,685.644
Tps. 30 and 31 N., R. 48 E., quarter corner between secs. 4 and 33; iron section post stamped "2614"	2,612.524
Tps. 30 and 31 N., R. 48 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2606"	2,604.830
Tps. 30 and 31 N., R. 48 E., near quarter corner between secs. 5 and 32; wooden stake marked "2631"	2,629.40

Corner of Tps. 31 and 32 N., Rs. 51 and 52 E., west along township line to corner of Tps. 31 and 32 N., Rs. 49 and 50 E., thence northwest 1 mile.

Tps. 31 and 32 N., Rs. 51 and 52, township corner; iron post stamped "2596"	2,594.967
Tps. 31 and 32 N., R. 51 E., quarter corner between secs. 1 and 36; iron section post stamped "2621"	2,619.424
Tps. 31 and 32 N., R. 51 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2627"	2,625.496
Tps. 31 and 32 N., R. 51 E., quarter corner between secs. 2 and 35; iron section post stamped "2633"	2,631.075
Tps. 31 and 32 N., R. 51 E., corner of secs. 2, 3, 34, and 35; iron section post stamped "2620"	2,618.595
Tps. 31 and 32 N., R. 51 E., quarter corner between secs. 3 and 34; iron section post stamped "2649"	2,647.502
Tps. 31 and 32 N., R. 51 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2650"	2,648.304

	Feet.
Tps. 31 and 32 N., R. 51 E., quarter corner between secs. 4 and 33; iron section post stamped "2656"	2,654.471
Tps. 31 and 32 N., R. 51 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2652"	2,650.845
Tps. 31 and 32 N., R. 51 E., quarter corner between secs. 5 and 32; iron section post stamped "2664"	2,662.114
Tps. 31 and 32 N., R. 51 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "2664"	2,662.951
Tps. 31 and 32 N., R. 51 E., quarter corner between secs. 6 and 31; iron section post stamped "2658"	2,656.221
Tps. 31 and 32 N., Rs. 50 and 51 E., township corner; iron post stamped "2670"	2,669.015
Tps. 31 and 32 N., R. 50 E., quarter corner between secs. 1 and 36; iron section post stamped "2588"	2,586.808
Tps. 31 and 32 N., R. 50 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2685"	2,683.623
Tps. 31 and 32 N., R. 50 E., quarter corner between secs. 2 and 35; iron section post stamped "2643"	2,642.314
Tps. 31 and 32 N., R. 50 E., quarter corner between secs. 3 and 34; iron section post stamped "2529"	2,528.282
Tps. 31 and 32 N., R. 50 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2457"	2,455.829
Tps. 31 and 32 N., R. 50 E., quarter corner between secs. 4 and 33; iron section post stamped "2408"	2,407.274
Tps. 31 and 32 N., R. 50 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2329"	2,328.071
Tps. 31 and 32 N., R. 50 E., quarter corner between secs. 5 and 32; iron section post stamped "2316"	2,314.561
Tps. 31 and 32 N., R. 50 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "2257"	2,255.525
Tps. 31 and 32 N., R. 50 E., quarter corner between secs. 6 and 31; iron section post stamped "2243"	2,241.788
Tps. 31 and 32 N., Rs. 49 and 50 E., township corner; iron post stamped "2196"	2,195.276
Frank Custer's ranch, at west corner of garden fence, north side of road; wooden stake marked "2192"	2,191.291

Corner of Tps. 31 and 32 N., Rs. 49 and 50 E., north 1 mile.

T. 32 N., Rs. 49 and 50 E., south sixteenth corner between secs. 31 and 36; stone marked "2215"	2,213.75
T. 32 N., Rs. 49 and 50 E., quarter corner between secs. 31 and 36; iron section post stamped "2235"	2,233.607
T. 32 N., Rs. 49 and 50 E., north sixteenth corner between secs. 31 and 36; stone marked "2265"	2,265.14
T. 32 N., Rs. 49 and 50 E., corner of secs. 30, 31, 25, and 36; iron section post stamped "2295"	2,293.760

Nearly all the following bench marks, established by J. H. Wilke in 1910, were by single unchecked sights and are therefore unreliable:

Point near Poplar west and south across Missouri River to sec. 7, T. 26 N., R. 51 E., thence northwest to Missouri River.

	Feet.
Poplar, 750 feet north and 150 feet east of Great Northern Ry. station; top of nut on iron post (Missouri River Commission bench mark 104/2)	1,997.242
Elevation of subsurface mark	1,993.242
Poplar, 0.5 mile east of, on east side of corner post of wire fence at northeast corner of field; nail marked "1968.9"	1,967.84
Poplar, 0.7 mile southeast of, first joint west of road crossing on north side of track, Great Northern Ry.; top of rail	1,967.1
Poplar, 1.3 miles southeast of, in highest point of northernmost peeled post 3 feet tall, just north of ferry across Missouri River; nail marked "1965"	1,963.95
Ferry, at west landing; surface of water of Missouri River	1,942.1
Ferry, in cable post west of, spike 6 inches above ground marked "1952"	1,950.76
Ferry, 0.5 mile southwest of, 30 feet east of road, 50 feet north of dim road east; nail in notch at root of 10-inch cottonwood tree, marked "1956.3"	1,955.18
Ferry, 1.1 miles southwest of, east edge of road, 2 feet above ground; spike in large leaning forked cottonwood tree, marked "1957.7"	1,956.61
Ferry, 1.6 miles southwest of, southeast corner of yard at small house plastered with mud, 3.85 feet above ground; spike in top of fence post, marked "1968"	1,966.97
T. 27 N., R. 51 E., between secs. 29 and 30, 150 yards north of new store; highest point of quarter section stone marked "1970"	1,969.40
T. 27 N., R. 51 E., quarter corner on east side of sec. 30, 2 feet north of rock corner; iron post stamped "1971"	1,970.030
T. 27 N., R. 51 E., 30 feet southwest of northeast corner of sec. 31, in corner fence post at southwest corner of road junction, near ground, spike marked "1989"	1,987.97
T. 27 N., R. 51 E., east side sec. 31, in southwest corner of field, at foot of hill, north side, where road turns east; due south from preceding bench mark; spike in foot of heavy brace to corner post marked "2020"	2,019.31
T. 27 N., R. 51 E., about sec. 32, south side of road up main right-hand coulee; highest point of rock marked "2075"	2,074.14
T. 27 N., R. 51 E., about sec. 32, north side of road; highest point of big rock painted "2129.4"	2,128.31
Davis, 2 miles south of store and post office, at west side of road, on top of hill at head of coulee running west, on Glendive Road; highest point of big white limestone rock marked "2195.7"	2,194.70
T. 26 N., R. 51 E., about sec. 6, 2 miles south of Davis store and post office, on Glendive Road, east of big white limestone; iron post stamped "2195".	2,194.049
Davis, 2 miles south and 0.2 mile west of, north end of point of ridge, south side of coulee; highest point on black rock marked "2117"	2,115.95
T. 27 N., R. 50 E., about 200 yards west of southeast corner of sec. 36, 20 feet north of road up right-hand coulee south of Tom Bowden's reservoir; highest point of small rock marked "2043.3"	2,042.30
Tom Bowden's reservoir, at divide between Red Water and coulee north side of road; highest point of pointed rock marked "2065.3"	2,064.32
T. 27 N., R. 50 E., sec. 36, 150 yards east of Red Water Creek in 24-inch cottonwood tree, northernmost and largest of row of six; spike in notch on north side, 1 foot above ground, marked "1976.3"	1,975.25

	Feet.
T. 27 N., R. 50 E., sec. 36, where clearly defined cow trail crosses Red Water Creek; surface of water	1,961.1
T. 27 N., R. 50 E., sec. 35, about 0.25 mile south of Tom Bowden's house, at corner post inside fence; spike in notch marked "1970"	1,969.04
T. 27 N., R. 50 E., sec. 35, 0.25 mile south of Tom Bowden's house, 2 feet west of corner fence post; iron post stamped "1970"	1,969.006
T. 27 N., R. 50 E., sec. 34, east edge of flat, east of road; highest point of rock marked "2162.4"	2,161.40
T. 27 N., R. 50 E., SW. ¼ sec. 34, at corner fence post southeast corner of field, 20 inches from ground; spike in notch on guy post marked "2161.6"	2,160.54
T. 26 N., R. 50 E., 150 yards southeast of northwest corner of sec. 3, in corner post of new wire fence, at southeast corner of yard around house, 3 inches above ground; spike marked "2141.3"	2,140.31
T. 26 N., R. 50 E., southeast corner of sec. 4, 2 feet west of corner on township line; iron post stamped "2148"	2,146.979
T. 27 N., R. 50 E., quarter corner on west side of sec. 4; highest point of corner stone marked "2147.6"	2,146.56
T. 26 N., R. 50 E., sec. 8, 40 feet west of road, on edge of hill on north side of small coulee, 0.25 mile north of steep cut bank in sharp bend of Red Water Creek; highest point on large rock marked "2089"	2,087.89
T. 26 N., R. 50 E., sec. 7, at northeast corner of yard fence at Dr. Atkinson's ranch on Red Water Creek; iron post stamped "2011"	2,009.977
T. 26 N., R. 50 E., 0.25 mile north and 0.25 mile east of southwest corner of sec. 7; 75 feet east of fence on south side of lane where lane turns north; highest point of rock marked "2026"	2,024.06
T. 26 N., R. 49 E., northeast corner of SE. ¼ SW. ¼ sec. 12, 5 feet north of corner post of fence; highest point of rock marked "2039"	2,037.99
T. 26 N., R. 49 E., northwest corner of SE. ¼ SE. ¼ sec. 11, southeast corner of field; spike in notch of corner fence post marked "2113.7"	2,112.73
T. 26 N., R. 49 E., sec. 11, 100 yards above dam on left side of coulee going up; highest point of rock marked "2105"	2,104.01
T. 26 N., R. 49 E., southwest corner of sec. 11; top of corner rock marked "2127.2"	2,126.18
T. 26 N., R. 49 E., quarter corner on south side of sec. 10; top of corner rock marked "2147.8"	2,146.79
T. 26 N., R. 49 E., sec. 9, in coulee; highest point of larger of two rocks marked "2195.7"	2,194.76
T. 26 N., R. 49 E., quarter corner on south side of sec. 9; top of corner rock marked "2214.2"	2,213.22
T. 26 N., R. 49 E., quarter corner on south side of sec. 9, 4 feet north of corner rock; iron post stamped "2214"	2,213.000
T. 26 N., R. 49 E., about 100 yards northwest from southeast corner of sec. 8, on edge of flat; highest point of rock marked "2226"	2,225.76
T. 26 N., R. 49 E., 100 yards west of big coulee; top of large rock marked "2212.5"	2,211.52
T. 26 N., R. 49 E., southeast corner of sec. 7; top of corner stone marked "2217.2"	2,216.28
T. 26 N., R. 49 E., quarter corner on south side of sec. 7; top of corner rock marked "2217.3"	2,216.40
T. 26 N., R. 49 E., southwest corner of sec. 7; top of corner stone marked "2179.5"	2,178.55
Burch, post office, sec. 13, T. 26 N., R. 48 E., in bed of creek, 50 feet west of where road crosses south fork of Nickwall Creek; highest point of large rock marked "2144.9"	2,143.97

	Feet.
Burch, sec. 13, T. 26 N., R. 48 E., at forks of road west of post office; highest point of large rock marked "2171.1"	2,170.23
T. 26 N., R. 48 E., on section line between secs. 13 and 14, north side of east end of lane; spike in fence post marked "2119.7"	2,118.74
T. 26 N., R. 48 E., sec. 13, 2 feet outside wire fence on north side of lane running west from fence near section line; iron post stamped "2220"	2,219.192
T. 26 N., R. 48 E., sec. 12, inside corner of field with furrow plowed on south and east sides; highest point on flat rock marked "2165"	2,163.12
T. 26 N., R. 48 E., sec. 11, 50 feet west and 300 feet south of high post to mark northeast corner of section before subdivision; highest point of large rock marked "2204.6"	2,203.70
T. 26 N., R. 48 E., sec. 2, 200 yards northwest of two trees in north fork of Nickwall Creek at old corral; highest point of large rock	2,157.49
T. 26 N., R. 48 E., sec. 2, just under edge of badlands; highest point of large rock marked "2201.9"	2,200.99
Badlands, on spur ridge; highest point on sandstone marked "2182.6"	2,181.69
T. 27 N., R. 48 E., about sec. 27, on west side of ridge, in plain view from road on west; white rock marked "2148"	2,147.16

Sec. 7, T. 26 N., R. 51 E., south, east, and north to northeast corner of sec. 33, T. 27 N., R. 52 E.

T. 26 N., R. 51 E., sec. 6, west edge of road; highest point of large flat rock marked "2219.6"	2,218.64
T. 26 N., R. 51 E., about sec. 7, west side of road, at head of coulee; rock at top of hill marked "2263"	2,262.02
T. 26 N., R. 51 E., about sec. 8, north side of road, 200 yards southeast of newly roofed cabin; highest point of rock marked "2275"	2,274.02
T. 26 N., R. 51 E., about sec. 17, 50 feet north of road forks where Glendive road goes up on terrace, near badlands; highest point of rock marked "2282.3"	2,281.35
T. 26 N., R. 51 E., about sec. 17, 100 feet south of road forks, where Glendive road goes up on terrace, near badlands; iron post stamped "2284"	2,283.036
T. 26 N., R. 51 E., about sec. 17, at southeast corner of new hay corral, 250 yards northwest of prominent butte in coulee; spike in post, 6 inches from ground, marked "2232.6"	2,231.59
T. 26 N., R. 51 E., about sec. 16, near point of ridge, 200 yards southwest of new hay corral; highest point of large rock marked "2175.2"	2,174.26
T. 26 N., R. 51 E., about sec. 16, east side of small coulee; highest point of large porous rock marked "2194.9"	2,193.88
T. 26 N., R. 51 E., about sec. 15, on flat; top of rock marked "2185"	2,184.0
T. 26 N., R. 51 E., about sec. 15, west side of big coulee; black rock marked "2129.3"	2,128.38
T. 26 N., R. 51 E., about sec. 15, on hillside west of big coulee; highest point of one of a number of large round rocks marked "2100"	2,098.02
T. 26 N., R. 51 E., about sec. 15, 75 feet northwest of stake at northwest corner of Gallagher's land; top of rock marked "2181.7"	2,180.75
T. 26 N., R. 51 E., about sec. 15, east of big coulee, on hillside; highest point of large flat white rock marked "2118"	2,117.01
T. 26 N., R. 51 E., about sec. 14; highest point of white rock marked "2171.7"	2,170.74
T. 26 N., R. 51 E., about sec. 14, on top of hill; top of rock 10 feet square marked "2194.4"	2,193.48
T. 26 N., R. 51 E., about sec. 14, on south side of white rock 10 feet square and 4 feet high; iron post stamped "2193"	2,192.035

	Feet.
T. 26 N., R. 51 E., about sec. 13, on east slope of hill; highest point of white rock 6 feet square marked "2090.6"	2,089.
T. 26 N., R. 51 E., about sec. 13, north side of coulee; top of large sharp-pointed rock marked "2183.4"	2,182.
T. 26 N., R. 52 E., about sec. 18, on point west of big coulee; highest point of large, spotted, and partly crumbled rock marked "2215.7"	2,214.
T. 26 N., R. 52 E., about sec. 18, on west side of flat hillside; highest point of prominent white rock marked "2234.4"	2,233.
T. 26 N., R. 52 E., about sec. 17, on point of ridge, south side of small coulee (first south of spring); highest point of small flat rock marked "2150.7"	2,149.
T. 26 N., R. 52 E., about sec. 16, at foot of small ridge in coulee, 200 feet west of creek bed; top of rock marked "2100.5"	2,099.
T. 26 N., R. 52 E., about sec. 16, on side of small ridge, in big coulee, 200 feet west of creek bed; iron post stamped "2102"	2,101.
T. 26 N., R. 52 E., about sec. 9, in bed of coulee at small stump; sandstone marked "2041.6"	2,040.
T. 26 N., R. 52 E., about sec. 5, near foot of ridge, 250 feet north of tree in bend of coulee; small rock marked "2007.6"	2,006.
T. 27 N., R. 52 E., sec. 32, south side of section; top of quarter section stone marked "1999.9"	1,998.
T. 27 N., R. 52 E., about sec. 33, at gate one-half mile east of Brown windmill at house, where 3 fences join; top of rock marked "1973.3"	1,972.
T. 27 N., R. 52 E., about sec. 33, at gate one-half mile east of Brown windmill at Reuz house; iron post stamped "1973"	1,972.
T. 27 N., R. 52 E., nearly 0.25 mile west of northeast corner of sec. 33, west side of small draw, 50 yards west of Kern's house; spike in root of small tree marked "1964.2"	1,963.

BROCTON 30′ QUADRANGLE.

Corner of Tps. 28 and 29, Rs. 51 and 52 E., east along township line to sec. 3, T. 29 N., R. 54 E.

T. 28 N., R. 52 E., witness corner to closing corner of secs. 3 and 4; iron section post stamped "2092"	2,090.
T. 29 N., R. 52 E., witness corner to closing corner of secs. 31 and 32; iron section post stamped "2087"	2,085.
T. 29 N., R. 52 E., south quarter corner of sec. 32; stone	2,054.
T. 28 N., R. 52 E., witness corner to closing corner of secs. 32 and 33; iron section post stamped "2060"	2,059.
T. 29 N., R. 52 E., witness corner to standard corner of secs. 32 and 33; iron section post stamped "2059"	2,058.
T. 29 N., R. 52 E., south quarter corner of sec. 33; stone	2,062.
T. 28 N., R. 52 E., witness corner to closing corner of secs. 2 and 1; iron section post stamped "2053"	2,052.
T. 29 N., R. 52 E., witness corner to standard corner of secs. 33 and 34; iron section post stamped "2053"	2,051.
T. 28 N., Rs. 52 and 53 E., witness corner to closing township corner iron post stamped "2036"	2,035.
T. 29 N., R. 52 E., witness corner to standard corner of secs. 34 and 35; iron section post stamped "2042"	2,040.
T. 29 N., R. 52 E., witness corner south quarter corner of sec. 35; iron section post stamped "2047"	2,045.
T. 28 N., R. 53 E., witness corner to closing corner of secs. 5 and 6; iron section post stamped "2054"	2,053.

	Feet.
T. 29 N., R. 52 E., witness corner to standard corner of secs. 35 and 36; iron section post stamped "2057"	2,056.360
T. 29 N., R. 52 E., witness corner south quarter corner of sec. 36; iron section post stamped "2097"	2,096.301
T. 28 N., R. 50 E., witness corner to closing corner secs. 4 and 5; iron section post stamped "2111"	2,109.794
T. 29 N., Rs. 52 and 53 E., witness corner to standard township corner iron post stamped "2100"	2,099.396
T. 29 N., R. 53 E., witness corner to south quarter corner of sec. 31; iron section post stamped "2141"	2,139.820
T. 29 N., R. 53 E., witness corner to closing corner of secs. 3 and 4; iron section post stamped "2139"	2,137.844
T. 29 N., R. 53 E., witness corner to south corner of secs. 31 and 32; iron section post stamped "2142"	2,140.505
T. 29 N., R. 53 E., witness corner to south quarter corner of sec. 32; iron section post stamped "2143"	2,142.001
T. 28 N., R. 53 E., witness corner to closing corner of secs. 2 and 3; iron section post stamped "2190"	2,188.821
T. 29 N., R. 53 E., witness corner to standard corner of secs. 32 and 33; iron section post stamped "2246"	2,244.737
T. 29 N., R. 53 E., witness corner to south quarter corner of sec. 33; iron section post stamped "2270"	2,269.109
T. 28 N., R. 53 E., NE. ¼ sec. 2, triangulation station Syp; iron post stamped "2369"	2,367.554
T. 28 N., R. 53 E., witness corner to closing corner of secs. 1 and 2, iron section post stamped "2296"	2,295.012
T. 29 N., R. 53 E., witness corner to standard corner of secs. 33 and 34; iron section post stamped "2246"	2,244.825
T. 29 N., R. 53 E., witness corner to south quarter corner of sec. 34; iron section post stamped "2211"	2,209.455
T. 28 N., Rs. 53 and 54 E., witness corner to closing township corner; iron post stamped "2180"	2,178.805
T. 29 N., R. 53 E., witness corner to standard corner of secs. 34 and 35; iron section post stamped "2163"	2,161.582
T. 29 N., R. 53 E., witness corner to south quarter corner of sec. 35; iron section post stamped "2159"	2,157.442
T. 28 N., R. 54 E., witness corner to closing corner of secs. 5 and 6; iron section post stamped "2141"	2,139.751
T. 29 N., R. 53 E., witness corner to standard corner of secs. 35 and 36; iron section post stamped "2134"	2,133.286
T. 29 N., R. 53 E., witness corner to south quarter corner of sec. 36; iron section post stamped "2119"	2,117.760
T. 28 N., R. 54 E., witness corner to closing corner of secs. 4 and 5; iron section post stamped "2089"	2,087.587
T. 29 N., Rs. 53 and 54 E., witness corner to standard township corner; iron post stamped "2069"	2,067.741
T. 29 N., R. 54 E., witness corner to south quarter corner of sec. 31; iron section post stamped "2002"	2,001.352
T. 28 N., R. 54 E., witness corner to closing corner of secs. 3 and 4; iron section post stamped "2004"	2,002.899
T. 29 N., R. 54 E., witness corner to south corner of secs. 31 and 32; iron section post stamped "1984"	1,983.313
T. 29 N., R. 54 E., witness corner to south quarter corner of sec. 32; iron section post stamped "2002"	2,000.430

	Feet.
T. 28 N., R. 54 E., witness corner to closing corner of secs. 2 and 3; iron section post stamped "2000"	1,999.165
T. 29 N., R. 54 E., witness corner to south corner of secs. 32 and 33; iron section post stamped "2004"	2,002.778
T. 29 N., R. 54 E., witness corner to south quarter corner of sec. 33; iron section post stamped "1987"	1,985.801
T. 28 N., R. 54 E., witness corner to closing corner of secs. 1 and 2; iron section post stamped "1969"	1,967.493
T. 29 N., R. 54 E., witness corner to standard corner of secs. 33 and 34; iron post stamped "1945"	1,943.480

Corner of Tps. 29 and 30 N., Rs. 51 and 52 E., east along township line to southwest sec. 33, T. 30 N., R. 54 E.

Tps. 29 and 30 N., R. 52 E., quarter corner between secs. 5 and 32; iron section post	2,194.643
Tps. 29 and 30 N., R. 52 E., corner of secs. 4, 5, 32, and 33; iron section post	2,179.219
Tps. 29 and 30 N., R. 52 E., quarter corner between secs. 4 and 33; iron section post	2,165.573
Tps. 29 and 30 N., R. 52 E., corner of secs. 3, 4, 33, and 34; iron section post	2,143.886
Tps. 29 and 30 N., R. 52 E., quarter corner of secs. 3 and 34; iron section post	2,133.549
Tps. 29 and 30 N., R. 52 E., corner of secs. 2, 3, 34, and 35; iron section post	2,135.725
Tps. 29 and 30 N., R. 52 E., quarter corner of secs. 2 and 35; iron section post	2,136.722
Tps. 29 and 30 N., R. 52 E., corner of secs. 1, 2, 35, and 36; iron section post	2,134.439
Tps. 29 and 30 N., R. 52 E., quarter corner of secs. 1 and 36; iron section post	2,123.612
Tps. 29 and 30 N., Rs. 52 and 53, township corner; iron post	2,094.863
Tps. 29 and 30 N., R. 53 E., quarter corner between secs. 6 and 31; iron section post stamped "2104"	2,102.632
Tps. 29 and 30 N., R. 53 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "2093"	2,092.103
Tps. 29 and 30 N., R. 53 E., quarter corner between secs. 5 and 32; iron section post stamped "2085"	2,083.570
Tps. 29 and 30 N., R. 53 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2067"	2,065.644
Tps. 29 and 30 N., R. 53 E., quarter corner between secs. 4 and 33; iron section post stamped "2054"	2,053.230
Tps. 29 and 30 N., R. 53 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2054"	2,053.119
Tps. 29 and 30 N., R. 53 E., quarter corner between secs. 3 and 34; iron section post stamped "2036"	2,034.811
Tps. 29 and 30 N., R. 53 E., corner of secs. 2, 3, 34, and 35; iron section post stamped "2019"	2,017.763
Tps. 29 and 30 N., R. 53 E., quarter corner between secs. 2 and 35; iron section post stamped "2016"	2,014.917
Tps. 29 and 30 N., R. 53 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "1989"	1,987.293
Tps. 29 and 30 N., R. 53 E., quarter corner between secs. 1 and 36; iron section post stamped "1988"	1,986.544

	Feet.
Tps. 29 and 30 N., Rs. 53 and 54 E., township corner; iron post stamped "2017"	2,015.297
Tps. 29 and 30 N., R. 54 E., quarter corner between secs. 6 and 31; iron section post stamped "1966"	1,964.180
Tps. 29 and 30 N., R. 54 E., east sixteenth corner between secs. 31 and 6; stone	1,952.70
Tps. 29 and 30 N., R. 54 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "1930"	1,928.903
Tps. 29 and 30 N., R. 54 E., west sixteenth corner between secs. 5 and 32; stone	1,924.41
Tps. 29 and 30 N., R. 54 E., quarter corner between secs. 5 and 32; iron section post stamped "1927"	1,925.481
Tps. 29 and 30 N., R. 54 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "1929"	1,927.524
Corner of Tps. 30 and 31 N., Rs. 51 and 52 E., east along township line to sec. 6, T. 30 N., R. 55 E.	
Tps. 30 and 31 N., R. 52 E., quarter corner between secs. 6 and 31; iron section post stamped "2415"	2,414.127
Tps. 30 and 31 N., R. 52 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "2501"	2,499.760
Tps. 30 and 31 N., R. 52 E., quarter corner between secs. 5 and 32; iron section post stamped "2439"	2,438.249
Tps. 30 and 31 N., R. 52 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2399"	2,398.110
Tps. 30 and 31 N., R. 52 E., quarter corner between secs. 4 and 33; iron section post stamped "2351"	2,350.297
Tps. 30 and 31 N., R. 52 E., corner of secs. 4, 3, 33, and 34; iron section post stamped "2416"	2,415.256
Tps. 30 and 31 N., R. 52 E., quarter corner between secs. 3 and 34; iron section post stamped "2317"	2,316.572
Tps. 30 and 31 N., R. 52 E., corner of secs. 2, 3, 34, and 35; iron section post stamped "2319"	2,318.407
Tps. 30 and 31 N., R. 52 E., quarter corner between secs. 2 and 35; iron section post stamped "2331"	2,330.103
Tps. 30 and 31 N., R. 52 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2359"	2,358.296
Tps. 30 and 31 N., R. 52 E., quarter corner secs. 1 and 36; iron section post stamped "2349"	2,348.119
Tps. 30 and 31 N., Rs. 52 and 53 E., township corner; iron post stamped "2339"	2,338.137
Tps. 30 and 31 N., R. 53 E., quarter corner between secs. 6 and 31; iron section post stamped "2305"	2,304.247
Tps. 30 and 31 N., R. 53 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "2285"	2,283.496
Tps. 30 and 31, R. 53 E., quarter corner between secs. 5 and 32; iron section post stamped "2233"	2,231.498
Tps. 30 and 31 N., R. 53 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2222"	2,220.985
Tps. 30 and 31 N., R. 53 E., quarter corner between secs. 4 and 33; iron section post stamped "2228"	2,227.024
Tps. 30 and 31 N., R. 53 E., corner of secs. 4, 3, 33, and 34; iron section post stamped "2181"	2,180.266
Tps. 30 and 31 N., R. 53 E., quarter corner between secs. 3 and 34; iron section post stamped "2149"	2,147.423

	Feet.
Tps. 30 and 31 N., R. 53 E., corner of secs. 2, 3, 34, and 35; iron section post stamped "2127"	2,126.254
Tps. 30 and 31 N., R. 53 E., quarter corner between secs. 2 and 35; iron section post stamped "2044"	2,043.432
Tps. 30 and 31 N., R. 53 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2065"	2,063.784
Tps. 30 and 31 N., R. 53 E., quarter corner between secs. 1 and 36; iron section post stamped "2101"	2,099.913
Tps. 30 and 31 N., Rs. 53 and 54 E., township corner; iron post stamped "2117"	2,115.451
Tps. 30 and 31 N., R. 54 E., quarter corner between secs. 6 and 31; iron section post stamped "2117"	2,116.211
Tps. 30 and 31 N., R. 54 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "2104"	2,102.436
Tps. 30 and 31 N., R. 54 E., quarter corner between secs. 5 and 32; iron section post stamped "2091"	2,089.836
Tps. 30 and 31 N., R. 54 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2084"	2,082.337
Tps. 30 and 31 N., R. 54 E., quarter corner between secs. 4 and 33; iron section post stamped "2092"	2,090.988
Tps. 30 and 31 N., R. 54 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2086"	2,085.238
Tps. 30 and 31 N., R. 54 E., quarter corner between secs. 3 and 34; iron section post stamped "2051"	2,049.808
Tps. 30 and 31 N., R. 54 E., corner of secs. 2, 3, 34, and 35; iron section post stamped "2086"	2,084.912
Tps. 30 and 31 N., R. 54 E., quarter corner between secs. 2 and 35; iron section post stamped "2088"	2,086.858
Tps. 30 and 31 N., R. 54 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2063"	2,062.149
Tps. 30 and 31 N., R. 54 E., quarter corner between secs. 1 and 36; iron section post stamped "2036"	2,035.128
Tps. 30 and 31 N., Rs. 54 and 55 E., township corner; iron post stamped "2008"	2,007.363
Tps. 30 and 31 N., R. 55 E., quarter corner between secs. 6 and 31; iron section post stamped "1984"	1,983.261
Tps. 30 and 31 N., R. 55 E., about 0.4 mile south of quarter corner between secs. 6 and 31; wooden hub with nail point (United States Reclamation Service bench mark M 23)	1,944.601

Corner of Tps. 31 and 32 N., Rs. 51 and 52 E., east along township line to sec. 4, T. 31 N., R. 55 E.

Tps. 31 and 32 N., R. 52 E., quarter corner between secs. 6 and 31; iron section post stamped "2544"	2,542.454
Tps. 31 and 32 N., R. 52 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "2530"	2,528.434
Tps. 31 and 32 N., R. 52 E., quarter corner between secs. 5 and 32; iron section post stamped "2406"	2,404.451
Tps. 31 and 32 N., R. 52 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2365"	2,363.564
Tps. 31 and 32 N., R. 52 E., quarter corner between secs. 4 and 33; iron section post stamped "2362"	2,360.698
Tps. 31 and 32 N., R. 52 E., coner of secs. 3, 4, 33, and 34; iron section post stamped "2276"	2,274.861

	Feet.
Tps. 31 and 32 N., R. 52 E., quarter corner between secs. 3 and 34; iron section post stamped "2321"	2,319.837
Tps. 31 and 32 N., R. 52 E., corner of secs. 2, 3, 34, and 35; iron section post stamped "2389"	2,387.491
Tps. 31 and 32 N., R. 52 E., quarter corner between secs. 2 and 35; iron section post stamped "2423"	2,421.972
Tps. 31 and 32 N., R. 52 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2478"	2,476.729
Tps. 31 and 32 N., R. 52 E., quarter corner between secs. 1 and 36; iron section post stamped "2467"	2,465.751
Tps. 31 and 32 N., Rs. 52 and 53 E., township corner; iron post stamped "2412"	2,410.315
Tps. 31 and 32 N., R. 53 E., quarter corner between secs. 6 and 31; iron section post stamped "2396"	2,394.959
Tps. 31 and 32 N., R. 53 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "2289"	2,287.528
Tps. 31 and 32 N., R. 53 E., quarter corner between secs. 5 and 32; iron section post stamped "2217"	2,215.635
Tps. 31 and 32 N., R. 53 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2195"	2,193.486
Tps. 31 and 32 N., R. 53 E., quarter corner between secs. 4 and 33; iron section post stamped "2208"	2,207.056
Tps. 31 and 32 N., R. 53 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2271"	2,269.654
Tps. 31 and 32 N., R. 53 E., quarter corner between secs. 3 and 34; iron section post stamped "2311"	2,309.505
Tps. 31 and 32 N., R. 53 E., corner of secs. 2, 3, 34, and 35; iron section post stamped "2313"	2,311.816
Tps. 31 and 32 N., R. 53 E., quarter corner between secs. 2 and 35; iron section post stamped "2359"	2,357.767
Tps. 31 and 32 N., R. 53 E., corner of secs. 1, 2, 35, and 36; iron post stamped "2385"	2,383.428
Tps. 31 and 32 N., R. 53 E., quarter corner between secs. 1 and 36; iron section post stamped "2376"	2,374.668
Tps. 31 and 32 N., Rs. 53 and 54 E., township corner; iron post stamped "2368"	2,366.909
Tps. 31 and 32 N., R. 54 E., quarter corner between secs. 6 and 31; iron section post stamped "2371"	2,369.657
Tps. 31 and 32 N., R. 54 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "2354"	2,352.947
Tps. 31 and 32 N., R. 54 E., quarter corner between secs. 32 and 5; iron post not stamped. (To be reset.)	
Tps. 31 and 32 N., R. 54 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "2337"	2,335.476
Tps. 31 and 32 N., R. 54 E., quarter corner between secs. 4 and 33; iron section post stamped "2334"	2,332.969
Tps. 31 and 32 N., R. 54 E., corner of secs. 3, 4, 33, and 34; iron section post stamped "2295"	2,293.284
Tps. 31 and 32 N., R. 54 E., near quarter corner between secs. 3 and 34; painted circle on rock	2,267.07
Tps. 31 and 32 N., R. 54 E., corner of secs, 2, 3, 34, and 35; iron section post stamped "2207"	2,205.630
Tps. 31 and 32 N., R. 54 E., quarter corner between secs. 2 and 35; iron section post stamped "2137"	2,135.248

	Feet.
Tps. 31 and 32 N., R. 54 E., corner of secs. 1, 2, 35, and 36; iron section post stamped "2163"	2,161.778
Tps. 31 and 32 N., R. 54 E., near quarter corner between secs. 1 and 36; painted circle on rock; marked "2159"	2,157.45
Tps. 31 and 32 N., Rs. 54 and 55 E., township corner; iron post stamped "2096"	2,094.637
Tps. 31 and 32 N., R. 55 E., quarter corner between secs. 6 and 31; iron section post stamped "2076"	2,074.732
Tps. 31 and 32 N., R. 55 E., corner of secs. 5, 6, 31, and 32; iron section post stamped "2031"	2,029.844
Tps. 31 and 32 N., R. 55 E., corner of secs. 4, 5, 32, and 33; iron section post stamped "1957"	1,955.881
Tps. 31 N., R. 55 E., north sixteenth corner between secs. 4 and 5; stone marked "1953"	1,951.81
Tps. 31 N., R. 55 E., quarter corner between secs. 4 and 5; iron section post stamped "1952"	1,950.559

Corner of Tps. 30 and 31 N., Rs. 52 and 53 E., north along range line to T. 32.

Tps. 30 and 31 N., Rs. 52 and 53 E., township corner; iron post stamped "2339"	2,338.137
Tps. 31 N., Rs. 52 and 53 E., quarter corner between secs. 31 and 36; iron section post stamped "2308"	2,306.965
Tps. 31 N., Rs. 52 and 53 E., corner of secs. 30, 31, 25, and 36; iron section post stamped "2293"	2,291.444
T. 31 N., Rs. 52 and 53 E., quarter corner between secs. 30 and 25; iron section post stamped "2274"	(Moved.)
T. 31 N., Rs. 52 and 53 E., corner of secs. 24, 25, 19, and 30; iron section post stamped "2250"	(Moved.)
T. 31 N., Rs. 52 and 53 E., quarter corner between secs, 19 and 24; iron section post stamped "2198"	(Moved.)
T. 31 N., Rs. 52 and 53 E., corner of secs. 18, 19, 13, and 24; iron section post stamped "2174"	(Moved.)
T. 31 N., Rs. 52 and 53 E., quarter corner between secs. 13 and 18; iron section post stamped "2205"	2,203.510
T. 31 N., Rs. 52 and 53 E., corner of secs. 12, 13, 7, and 18; iron section post stamped "2270"	2,268.610
T. 31 N., Rs. 52 and 53 E., quarter corner between secs. 7 and 12; iron section post stamped "2371"	2,369.424
T. 31 N., Rs. 52 and 53 E., corner of secs. 1, 6, 7, and 12; iron section post stamped "2377"	2,376.028
T. 31 N., Rs. 52 and 53 E., quarter corner between secs. 1 and 6; iron section post stamped "2483"	2,482.035

Sec. 33, T. 29 N., R. 54 E., southeast to Missouri River Commission bench mark 112/2 on Great Northern Ry.

T. 29 N., Rs. 54 and 55 E., witness corner to corner of secs. 1, 6, 7, and 12; iron section post stamped "1922"	1,921.012
T. 28 N., Rs. 54 and 55 E., witness corner to quarter corner between secs. 7 and 12; iron section post stamped "1923"	1,922.267
T. 28 N., Rs. 54 and 55 E., witness corner to corner of secs. 12, 13, 6, and 18; iron section post stamped "1939"	1,937.628
T. 28 N., Rs. 54 and 55 E., witness corner to quarter corner between secs. 13 and 18; iron section post stamped "1975"	1,974.404

	Feet.
T. 28 N., Rs. 54 and 55 E., witness corner to corner of secs. 18, 19, 13, and 24; iron section post stamped "2042"	2,040.481
T. 28 N., Rs. 54 and 55 E., witness corner to quarter corner between secs. 19 and 24; iron section post stamped "2073"	2,072.309
T. 28 N., Rs. 54 and 55 E., witness corner to corner of secs. 24, 25, 19, and 30; iron section post stamped "2081"	2,079.749
T. 28 N., Rs. 54 and 55 E., witness corner to quarter corner between secs. 25 and 30; iron section post stamped "2006"	2,005.064
Blair, Great Northern Ry. station, 2.25 miles west of, east bank of Missouri River, about 1.25 miles west of bridge 225, 240 feet north of track; Missouri River Commission bench mark 112/2, Commission elevation 1,946.481; subsurface mark	1,947.254

Connection between Missouri River Commission bench marks 112/2 and 113/2.[1]

Blair, in front of station; top of north rail	1,933.02
Blair, 3,800 feet west of station, 135 feet south of track, on east bank of Missouri River, in pump house garden, southeast of gate. (Missouri River Commission bench mark 113/2; Commission elevation is same as United States Geological Survey value); title under iron post	1,923.564

Sec. 33, T. 29 N., R. 54 E., north along Big Muddy River to corner of Tps. 30 and 31 N., Rs. 53 and 54 E.

John Manning's ranch, in northeast corner of vegetable garden, 1 foot from corner fence post; township corner post; iron post stamped "1939"	1,937.461
John Manning's ranch, 3.2 miles northeast of, 1.4 miles northeast of ford on Big Muddy River, between road and river, clump of thorn apple trees stand alone on opposite side of river some distance from bank; iron post stamped "1927"	1,925.582
T. 30 N., Rs. 53 and 54 E., 1,100 feet north and 300 feet east of corner of secs. 1, 12, 6, and 7; paint mark on rock; rock pile marks location	2,076.17
T. 30 N., Rs. 53 and 54 E., quarter corner between secs. 1 and 6; iron section post stamped "2094"	2,093.080

Sec. 29, T. 30 N., R. 54 E., east to Reclamation Service bench mark No. M. 18.

Murray's ranch, 2 miles north of, at mouth of wide deep coulee draining east, 3 feet east of bench mark "M. 18," on west side of Big Muddy River, on east side of bluffs; iron post stamped "1939"	1,937.965

Nearly all the following bench marks, established by J. H. Wilke in 1910, were by single unchecked sights, and are therefore unreliable:

Northeast corner of sec. 33, T. 27 N., R. 52 E., northeast and north to Payguntasaba Indian village.

	Feet.
T. 27 N., R. 52 E., about sec. 27, at gate 0.1 mile south of Armstrong's house; nail in brace of fence marked "1948.8"	1,947.94
Armstrongs Landing, 2.2 miles southeast of, in corner post of old fence west of road where Missouri River bends north; spike marked "1948.6"	1,947.73
T. 27 N., R. 52 E., about 350 yards northwest of southeast corner of sec. 22, 200 feet east of bank of Missouri River, at sharp bend north; iron post stamped "1949"	1,948.039
T. 27 N., R. 52 E., about 300 feet southeast of northeast corner of sec. 22, west side of road, in south edge of woods; nail in notch of forked cottonwood tree marked "1945.5"	1,944.66

[1] The difference of elevation, 23.690 feet, as herein given is an average of four measures and differs by 0.773 foot from the difference published by the Missouri River Commission.

	Feet.
Armstrongs Landing, 0.4 mile south of, east edge of road, 150 feet north of turn north out of opening; notch in 28-inch leaning cottonwood tree marked "1944.5"	1,943.62
Armstrongs Landing, on south bank of Missouri River; spike in 12-inch post 10 feet high marked "1941.7"	1,940.79
Armstrongs Landing; surface of water, Missouri River, Oct. 8, 1910	1,924.8
Armstrongs Landing, 0.2 mile north of, north side of road; top of Indian allotment post 76, marked "1944.2"	1,943.29
Armstrongs Landing, 1.3 miles north of, north side of road, east of cripple half-breed's house; top of Indian allotment post	1,994.01
Payguntasaba Indian village, west of; Missouri River Commission bench mark; top edge of gas pipe (cap gone); iron post stamped (no value given)	1,993.20
Payguntasaba Indian village, just west of; top of stone beneath above-described gas pipe	1,989.494

PLENTYWOOD 30′ QUADRANGLE.

Sec. 35, T. 33 N., R. 51 E., east along township line to sec. 35, T. 33 N., R. 55 E.

T. 33 N., R. 51 E., south quarter corner of sec. 36; iron section post stamped "2532"	2,530.880
T. 33 N., Rs. 51 and 52 E., standard township corner; iron post stamped "2530"	2,528.457
T. 33 N., R. 52 E., south quarter corner of sec. 31; iron section post stamped "2542"	2,540.811
T. 33 N., R. 52 E., south corner of secs. 31 and 32; iron section post stamped "2563"	2,561.522
T. 33 N., R. 52 E., south quarter corner of sec. 32; iron section post stamped "2584"	2,582.493
T. 33 N., R. 52 E., south corner of secs. 32 and 33; iron section post stamped "2587"	2,585.497
T. 33 N., R. 52 E., south quarter corner of sec. 33; iron section post stamped "2609"	2,607.606
T. 33 N., R. 52 E., south corner of secs. 33 and 34; iron section post stamped "2614"	2,613.211
T. 33 N., R. 52 E., south quarter corner of sec. 34; iron section post stamped "2597"	2,595.663
T. 33 N., R. 52 E., south corner of secs. 34 and 35; iron section post stamped "2584"	2,582.768
T. 33 N., R. 52 E., south quarter corner of sec. 35; iron section post stamped "2611"	2,609.698
T. 33 N., R. 52 E., south corner of secs. 35 and 36; iron section post stamped "2611"	2,610.283
T. 33 N., R. 52 E., south quarter corner of sec. 36; iron section post stamped "2511"	2,509.625
T. 33 N., Rs. 52 and 53 E., standard township corner; iron post stamped "2533"	2,532.375
T. 33 N., R. 53 E., south quarter corner of sec. 31; iron section post stamped "2541"	2,539.729
T. 33 N., R. 53 E., south corner of secs. 31 and 32; iron section post stamped "2596"	2,594.465
T. 33 N., R. 53 E., south quarter corner of sec. 32; iron section post stamped "2544"	2,542.707
T. 33 N., R. 53 E., south corner of secs. 32 and 33; iron section post stamped "2489"	2,488.131

	Feet.
T. 33 N., R. 53 E., south quarter corner of sec. 33; iron section post stamped "2431"	2,429.717
T. 33 N., R. 53 E., south corner of secs. 33 and 34; iron section post stamped "2359"	2,358.222
T. 33 N., R. 53 E., south quarter corner of sec. 34; iron section post stamped "2299"	2,298.198
T. 33 N., R. 53 E., south corner of secs. 34 and 35; iron section post stamped "2235"	2,233.827
T. 33 N., R. 53 E., south quarter corner of sec. 35; iron section post stamped "2198"	2,196.668
T. 33 N., R. 53 E., south corner of secs. 35 and 36; iron section post stamped "2196"	2,195.328
T. 33 N., R. 53 E., south quarter corner of sec. 36; iron section post stamped "2211"	2,210.276
T. 33 N., Rs. 53 and 54 E., standard township corner; iron post stamped "2207"	2,205.984
T. 33 N., R. 54 E., south quarter corner of sec. 31; iron section post stamped "2205"	2,203.985
T. 33 N., R. 54 E., south corner of secs. 31 and 32; iron section post stamped "2139"	2,138.302
T. 33 N., R. 54 E., south quarter corner of sec. 32; iron section post stamped "2117"	2,116.190
T. 33 N., R. 54 E., south corner of secs. 32 and 33; iron section post stamped "2144"	2,142.627
T. 33 N., R. 54 E., south quarter corner of sec. 33; iron section post stamped "2152"	2,150.810
T. 33 N., R. 54 E., south corner of secs. 33 and 34; iron section post stamped "2171"	2,169.763
T. 33 N., R. 54 E., south quarter corner of sec. 34; iron section post stamped "2182"	2,180.661
T. 33 N., Rs. 54 and 55 E., closing township corner; iron post stamped "2175"	2,173.457
T. 33 N., R. 54 E., south corner of secs. 34 and 35; iron section post stamped "2160"	2,158.375
T. 33 N., R. 54 E., south quarter corner of sec. 35; iron section post stamped "2173"	2,171.784
T. 33 N., R. 54 E., south corner of secs. 35 and 36; iron section post stamped "2213"	2,211.493
T. 33 N., R. 54 E., south quarter corner of sec. 36; iron section post stamped "2204"	2,203.316
T. 33 N., Rs. 54 and 55 E., standard township corner; iron post stamped "2124"	2,122.905
T. 33 N., R. 55 E., south quarter corner of sec. 31; iron section post stamped "2083"	3,081.890
T. 33 N., R. 55 E., south corner of secs. 31 and 32; iron section post stamped "2081"	2,080.321
T. 33 N., R. 55 E., south quarter corner of sec. 32; iron section post stamped "2066"	2,065.109
T. 33 N., R. 55 E., south corner of secs. 32 and 33; iron section post stamped "2049"	2,047.594
T. 33 N., R. 55 E., south quarter corner of sec. 33; iron section post stamped "2037"	2,035.969

	Feet.
T. 33 N., R. 55 E., south corner of secs. 33 and 34; iron section post stamped "2046"	2,045.112
T. 33 N., R. 55 E., south quarter corner of sec. 34; iron section post stamped "1980"	1,978.753
T. 33 N., R. 54 E., south corner of secs. 34 and 35; iron section post stamped "1975"	1,973.415

SCOBEY 30′ QUADRANGLE.

Tps. 31 and 32 N., Rs. 49 and 50 E., northwest to sec. 5, T. 32 N., R. 48 E.

Custer's ranch, 1.8 miles northwest of, at ford of Poplar River; surface of water, July 9, 1909	2,171.5
Custer's ranch, 1.9 miles northwest of, on south side of river, 0.25 mile northwest of ford of Poplar River near east end of a prominent line of bluffs on northeast side of river, south of poorly defined road; iron post stamped "2183"	2,181.888
Custer's ranch, 4.2 miles northwest of, at wagon ford over West Branch of Poplar River; surface of water, July 10, 1909	2,196.5
Custer's ranch, 5.2 miles northwest of, north side of West Branch of Poplar River, 1 mile northwest of wagon ford, 60 feet northeast of road; iron post stamped "2215"	2,213.630
Custer's ranch, 8.6 miles northwest of, north side of West Branch, about 1,600 feet southeast of the southeast end of very prominent 40-foot clay bluff, 110 feet north of river bank and 540 feet east of small lone cottonwood on river bank; iron post stamped "2251"	2,250.231
Custer's ranch, 11.7 miles northwest of, south side of West Branch; iron post stamped "2281"	2,280.376

Sec. 25, T. 32 N., R. 49 E., north and east along range line and township line to T. 33 N., Rs. 51 and 52 E.

T. 32 N., Rs. 49 and 50 E., quarter corner between secs. 25 and 30; iron section post stamped "2236"	2,234.790
T. 32 N., Rs. 49 and 50 E., corner of secs. 24, 25, 30, and 19; iron section post stamped "2318"	2,316.668
T. 32 N., Rs. 49 and 50 E., quarter corner between secs. 24 and 19; iron section post stamped "2396"	2,394.555
T. 32 N., Rs. 49 and 50 E., corner of secs. 18, 19, 13, and 24; iron section post stamped "2437"	2,436.185
T. 32 N., Rs. 49 and 50 E., quarter corner between secs. 13 and 18; iron section post stamped "2474"	2,472.629
T. 32 N., Rs. 49 and 50 E., corner of secs. 12, 13, 7, and 18; iron section post stamped "2541"	2,540.082
T. 32 N., Rs. 49 and 50 E., quarter corner between secs. 12 and 7; iron section post stamped "2566"	2,564.506
T. 32 N., Rs. 49 and 50 E., corner of secs. 1, 12, 6, and 7; iron section post stamped "2647"	2,646.042
T. 32 N., Rs. 49 and 50 E., quarter corner between secs. 1 and 6; iron section post stamped "2663"	2,662.520
T. 32 N., Rs. 49 and 50 E., [illegible] township corner; iron post stamped "2667"	2,666.262
T. 33 N., Rs. 49 and 50 E., [illegible] corner of sec. 35; iron section post stamped "2649"	2,648.161
T. 33 N., Rs. 49 and 50 E., [illegible] corner of secs. 35 and 36; iron section post stamped "2575"	2,574.325

	Feet.
T. 33 N., R. 49 E., south quarter corner of sec. 36; iron section post stamped "2616"	2,615.234
T. 33 N., Rs. 49 and 50, standard township corner; iron section post stamped "2615"	2,613.503
T. 33 N., R. 50 E., south quarter corner of sec. 31; ground elevation	2,628.2
T. 33 N., R. 50 E., about 0.25 mile north of south corner secs. 31 and 32, Morgan triangulation station; iron post stamped "2753"	2,751.657
T. 33 N., R. 50 E., south quarter corner of sec. 32; iron section post stamped "2678"	2,677.185
T. 33 N., R. 50 E., south corner of secs. 32 and 33; iron section post stamped "2695"	2,693.457
T. 33 N., R. 50 E., south quarter corner of sec. 33; iron section post stamped "2689"	2,687.962
T. 32 N., R. 50 E., closing corner of secs. 1 and 2; iron section post stamped "2669"	2,668.053
T. 33 N., R. 50 E., south quarter corner of sec. 34; iron section post stamped "2656"	2,654.726
Tps. 32 and 33 N., Rs. 50 and 51 E., closing township corner; iron post stamped "2660"	2,658.653
T. 33 N., R. 50 E., south corner of secs. 34 and 35; iron section post stamped "2659"	2,657.771
T. 33 N., R. 50 E., south quarter corner of sec. 35; iron section post stamped "2611"	2,610.158
T. 33 N., R. 50 E., south corner of secs. 35 and 36; iron section post stamped "2560"	2,559.097
T. 33 N., R. 50 E., south quarter corner of sec. 36; iron section post stamped "2545"	2,544.035
T. 33 N., Rs. 50 and 51 E., standard township corner; iron post stamped "2548"	2,546.729
T. 33 N., R. 51 E., south quarter corner of sec. 31; iron section post stamped "2529"	2,528.128
T. 33 N., R. 51 E., south corner of secs. 31 and 32; iron section post stamped "2495"	2,493.849
T. 33 N., R. 51 E., south quarter corner of sec. 32; iron section post stamped "2454"	2,453.313
T. 33 N., R. 51 E., south corner of secs. 32 and 33; iron section post stamped "2527"	2,525.446
T. 33 N., R. 51 E., south quarter corner of sec. 33; iron section post stamped "2526"	2,524.643
T. 33 N., R. 51 E., south corner of secs. 33 and 34; iron section post stamped "2522"	2,521.108
T. 33 N., R. 51 E., south quarter corner of sec. 34; iron section post stamped "2515"	2,513.881
T. 33 N., R. 51 E., south corner of secs. 34 and 35; iron section post stamped "2529"	2,527.522
T. 33 N., R. 51 E., south quarter corner of sec. 35; iron section post stamped "2536"	2,535.106
T. 33 N., R. 51 E., south corner of secs. 35 and 36; iron section post stamped "2540"	2,538.417
Quarter corner between secs. 25 and 30, T. 32 N., Rs. 50 and 51 E., north along range line to Tps. 32 and 33 N.	
T. 32 N., Rs. 50 and 51 E., quarter corner between secs. 25 and 30; iron section post stamped "2606"	2,604.909

	Feet.
T. 32 N., Rs. 50 and 51 E., corner of secs. 24, 25, 19, and 30; iron section post stamped "2624"	2,622.824
T. 32 N., Rs. 50 and 51 E., quarter corner between secs. 19 and 24; iron section post stamped "2654"	2,652.574
T. 32 N., Rs. 50 and 51 E., corner of secs. 18, 19, 13, and 24; iron section post stamped "2655"	2,653.854
T. 32 N., Rs. 50 and 51 E., quarter corner between secs. 13 and 18; iron section post stamped "2659"	2,657.564
T. 32 N., Rs. 50 and 51 E., corner of secs. 12, 13, 7, and 18; iron section post stamped "2635"	2,633.493
T. 32 N., Rs. 50 and 51 E., quarter corner between secs. 7 and 12; iron section post stamped "2644"	2,643.253
T. 32 N., Rs. 50 and 51 E., corner of secs. 6, 7, 1, and 12; iron section post stamped "2665"	2,664.042
T. 32 N., Rs. 50 and 51 E., quarter corner between secs. 1 and 6; iron section post stamped "2666"	2,664.543
T. 32 N., Rs. 50 and 51 E., closing township corner; iron post stamped "2660"	2,658.649

WHISKEY BUTTES QUADRANGLE.

Sec. 5, T. 32 N., R. 48 E., southwest to line between Rs. 46 and 47, thence south to sec. 25, T. 32 N., R. 47 E.

T. 32 N., Rs. 47 and 48 E., witness corner to closing township corner, south side of river, 240 feet south of bank, location marked by high cut clay bank on north edge with a small break in same where gully empties, Windy triangulation station bears S. 14° E.; iron post stamped "2296"	2,294.943
Cottonwood Creek, 90 feet south of, on small terrace, center of gap through which West Branch of Poplar River flows to join Cottonwood Creek, bears N. 10° W. about 0.8 mile; iron post stamped "2350"	2,349.050
T. 32 N., R. 46 E., northeast corner of sec. 13; iron section post stamped "2429"	(Moved.)
T. 32 N., R. 46 E., quarter corner of sec. 13; iron section post stamped "2431"	(Moved.)
T. 32 N., R. 46 E., northeast corner of sec. 24; iron section post stamped "2453"	(Moved.)
T. 32 N., R. 46 E., quarter corner of sec. 24; iron section post stamped "2492"	(Moved.)
T. 32 N., R. 46 E., northeast corner of sec. 25; iron section post stamped "2504"	(Moved.)
T. 32 N., R. 46 E., quarter corner of sec. 25; iron section post stamped "2546"	(Moved.)
T. 32 N., R. 46 E., northeast corner of sec. 36; iron section post stamped "2565"	(Moved.)

Single spur line into T. 33 N., R. 47 E.

T. 33 N., R. 47 E., standard corner of secs. 32 and 33; iron section post stamped "2345"	2,344.248

Sec. 12, T. 32 N., R. 46 E., north and west along range and township line to quarter corner of sec. 33, T. 33 N., R. 44 E. (spur line).

T. 32 N., R. 46 E., corner of secs. 12 and 13, on 11th guide meridian; iron section post stamped "2429"	(Moved.)
T. 32 N., R. 46 E., east quarter corner of sec. 12, on 11th guide meridian; iron section post stamped "2388"	(Moved.)

	Feet.
T. 32 N., R. 46 E., corner of secs. 1 and 12, on 11th guide meridian; iron section post stamped "2426"	(Moved.)
T. 32 N., R. 46 E., east quarter corner of sec. 1, on 11th guide meridian; iron section post stamped "2432"	(Moved.)
Tps. 32 and 33, Rs. 46 and 47 E., closing township corner; iron post stamped "2460"	2,458.808
T. 33 N., R. 46 E., south quarter corner of sec. 34; iron section post stamped "2474"	2,473.361
T. 33 N., R. 46 E., south corner of secs. 33 and 34; iron section post stamped "2492"	2,491.032
T. 33 N., R. 46 E., south quarter corner of sec. 33; iron section post stamped "2488"	2,486.676
T. 33 N., R. 46 E., south corner of secs. 32 and 33; iron section post stamped "2518"	2,516.564
T. 33 N., R. 46 E., south quarter corner of sec. 32; iron section post stamped "2554"	2,552.795
T. 33 N., R. 46 E., south corner of secs. 31 and 32; iron section post stamped "2564"	2,563.362
T. 33 N., R. 46 E., south quarter corner of sec. 31; iron section post stamped "2576"	2,575.085
T. 33 N., Rs. 45 and 46 E., standard township corner; iron post stamped "2604"	2,602.505
T. 33 N., R. 45 E., south quarter corner of sec. 36; iron section post stamped "2575"	2,573.590
T. 33 N., R. 45 E., south corner of secs. 35 and 36; iron section post stamped "2569"	2,568.271
T. 33 N., R. 45 E., south quarter corner of sec. 35; iron section post stamped "2595"	2,594.320
T. 33 N., R. 45 E., south corner of secs. 34 and 35; iron section post stamped "2712"	2,710.885
T. 33 N., R. 45 E., south quarter corner of sec. 34; iron section post stamped "2683"	2,682.158
T. 33 N., R. 45 E., south corner of secs. 33 and 34; iron section post stamped "2668"	2,666.507
T. 33 N., R. 45 E., south quarter corner of sec. 33; iron section post stamped "2696"	2,695.018
T. 33 N., R. 45 E., south corner of secs. 32 and 33; iron section post stamped "2704"	2,702.938
T. 33 N., R. 45 E., south quarter corner of sec. 32; iron section post stamped "2723"	2,722.011
T. 33 N., R. 45 E., south corner of secs. 31 and 32; iron section post stamped "2801"	2,799.747
T. 33 N., R. 45 E., south quarter corner of sec. 31; iron section post stamped "2785"	2,783.461
T. 33 N., Rs. 44 and 45 E., standard township corner; iron post stamped "2780"	2,778.497
T. 33 N., R. 44 E., south quarter corner of sec. 36; iron section post stamped "2813"	2,812.029
T. 33 N., R. 44 E., south corner of secs. 35 and 36; iron section post stamped "2893"	2,891.996
T. 33 N., R. 44 E., south quarter corner of sec. 35; iron section post stamped "2900"	2,898.537
T. 33 N., R. 44 E., south corner of secs. 34 and 35; iron section post stamped "2908"	2,906.545

	Feet.
T. 32 N., Rs. 44 and 45 E., closing corner; iron post stamped "2908"	2,907.44
T. 33 N., R. 44 E., south quarter corner of sec. 34; iron section post stamped "2914"	2,912.76
T. 33 N., R. 44 E., south corner of secs. 33 and 34; iron section post stamped "2908"	2,906.87
T. 33 N., R. 44 E., south quarter corner of sec. 33; iron section post stamped "2936"	2,935.12

Sec. 33, T. 33 N., R. 44 W., east along township line to sec. 36.

T. 33 N., R. 44 E., standard quarter corner of sec. 33; iron section post stamped "2936"	2,935.12
T. 33 N., R. 44 E., standard corner between secs. 32 and 33; iron post stamped "2953"	2,951.94
T. 33 N., R. 44 E., standard quarter corner of sec. 32; iron section post stamped "2953"	2,951.95
T. 33 N., R. 44 E., standard corner between secs. 31 and 32; iron section post stamped "2946"	2,945.27
T. 33 N., R. 44 E., standard quarter corner of sec. 31; iron section post stamped "2950"	2,949.19
T. 33 N., Rs. 43 and 44 E., standard corner; iron post stamped "2932"	2,930.69
T. 33 N., R. 43 E., standard quarter corner of sec. 36; iron section post stamped "2942"	2,940.75

QUADRANGLE TWO.

Corner of secs. 19, 30, 24, and 25, T. 32 N., Rs. 40 and 41 E., north along range line to closing corner of T. 32 N., Rs. 40 and 41 E., thence east along township line to standard corner of secs. 35 and 36, T. 33 N., R. 44 E.

T. 32 N., Rs. 40 and 41 E., corner of secs. 19, 24, 25, and 30; iron section post stamped "2828"	2,828.372
T. 32 N., Rs. 40 and 41 E., quarter corner between secs. 19 and 24; iron section post stamped "2769"	2,769.992
T. 32 N., Rs. 40 and 41 E., quarter corner between secs. 13 and 18; iron section post stamped "2707"	2,707.053
T. 32 N., Rs. 40 and 41 E., corner of secs. 7, 12, 13, and 18; iron section post stamped "2680"	2,680.218
T. 32 N., Rs. 40 and 41 E., quarter corner between secs. 7 and 12; iron section post stamped "2646"	2,646.362
T. 32 N., Rs. 40 and 41 E., corner of secs. 1, 6, 7, and 12; iron section post stamped "2678"	2,678.363
T. 32 N., Rs. 40 and 41 E., quarter corner between secs. 1 and 6; iron section post	2,686.494
T. 32 N., Rs. 40 and 41 E., closing corner; iron post stamped "2698"	2,698.048
T. 33 N., R. 40 E., standard quarter corner of sec. 35; iron section post stamped "2713"	2,712.037
T. 32 N., R. 41 E., closing quarter corner of sec. 6; iron section post stamped "2734"	2,732.707
T. 32 N., R. 41 E., closing corner of secs. 5 and 6; iron section post stamped "2713"	2,712.193
T. 33 N., R. 40 E., standard quarter corner of sec. 36; iron section post stamped "2712"	2,711.405
T. 32 N., R. 41 E., closing quarter corner of sec. 5; iron section post stamped "2708"	2,707.279
T. 33 N., Rs. 40 and 41 E., standard corner; iron post stamped "2686"	2,685.372

	Feet.
T. 32 N., R. 41 E., closing corner between secs. 4 and 5; iron section post stamped "2688"	2,686.687
T. 33 N., R. 41 E., standard quarter corner of sec. 31; iron section post stamped "2690"	2,689.002
T. 32 N., R. 41 E., closing quarter corner of sec. 4; iron section post stamped "2691"	2,689.812
T. 33 N., R. 41 E., standard corner between secs. 31 and 32; iron section post stamped "2697"	2,695.672
T. 33 N., R. 41 E., standard quarter corner of sec. 32; iron section post stamped "2706"	2,704.627
T. 32 N., R. 41 E., closing quarter corner of sec. 3; iron section post stamped "2711"	2,709.883
T. 33 N., R. 41 E., standard corner between secs. 32 and 33; iron section post stamped "2719"	2,718.277
T. 32 N., R. 41 E., closing corner between secs. 2 and 3; iron section post stamped "2723"	2,721.594
T. 33 N., R. 41 E., standard quarter corner of sec. 33; iron section post stamped "2723"	2,722.192
T. 32 N., R. 41 E., closing quarter corner of sec. 2; iron section post stamped "2724"	2,723.142
T. 33 N., R. 41 E., standard corner between secs. 33 and 34; iron section post stamped "2731"	2,729.928
T. 32 N., R. 41 E., closing corner between secs. 1 and 2; iron section post stamped "2732"	2,731.330
T. 33 N., R. 41 E., standard quarter corner of sec. 34; iron section post stamped "2746"	2,744.846
T. 32 N., R. 41 E., closing quarter corner of sec. 1; iron section post stamped "2753"	2,751.533
T. 33 N., R. 41 E., standard corner between secs. 34 and 35; iron section post stamped "2779"	2,777.943
T. 33 N., R. 41 E., standard quarter corner of sec. 35; iron section post stamped "2812"	2,810.703
T. 32 N., R. 42 E., closing corner between secs. 5 and 6; iron section post stamped "2858"	2,857.067
T. 33 N., R. 41 E., standard quarter corner of sec. 36; iron section post stamped "2916"	2,914.728
T. 33 N., Rs. 41 and 42 E., standard corner; iron post stamped "2933"	2,932.171
T. 33 N., R. 42 E., closing corner between secs. 4 and 5; iron section post stamped "2925"	2,923.786
T. 33 N., R. 42 E., standard quarter corner of sec. 31; iron section post stamped "2934"	2,932.835
T. 33 N., R. 42 E., standard corner between secs. 31 and 32; iron section post stamped "2934"	2,933.253
T. 33 N., R. 42 E., closing corner between secs. 3 and 4; iron section post stamped "2938"	2,937.202
T. 33 N., R. 42 E., standard quarter corner of sec. 32; iron section post stamped "2932"	2,930.697
T. 33 N., R. 42 E., standard corner between secs. 32 and 33; iron section post stamped "2944"	2,943.104
T. 32 N., R. 42 E., closing corner between secs. 2 and 3; iron section post stamped "2933"	2,931.615
T. 33 N., R. 42 E., standard quarter corner of sec. 33; iron section post stamped "2934"	2,932.659

	Feet.
T. 33 N., R. 42 E., standard corner between secs. 33 and 34; iron section post	2,934.703
T. 32 N., R. 42 E., closing corner between secs. 1 and 2; iron section post stamped "2931"	2,930.304
T. 33 N., R. 42 E., standard corner between secs. 34 and 35; iron section post stamped "2919"	2,917.773
T. 33 N., R. 42 E., standard quarter corner of sec. 35; iron section post stamped "2954"	2,952.778
T. 33 N., Rs. 42 and 43 E., standard corner between secs. 35 and 36; iron section post stamped "2949"	2,947.956
T. 33 N., R. 42 E., standard quarter corner of sec. 36; iron section post stamped "2910"	2,909.071
T. 33 N., Rs. 42 and 43 E., standard corner; iron post stamped "2889"	2,888.343
T. 33 N., R. 43 E., standard quarter corner of sec. 31; iron section post stamped "2855"	2,854.280
T. 33 N., R. 43 E., standard corner between secs. 31 and 32; iron section post stamped "2824"	2,823.276
T. 33 N., R. 43 E., standard quarter corner of sec. 32; iron section post stamped "2919"	2,918.324
T. 33 N., R. 43 E., standard corner between secs. 32 and 33; iron section post stamped "2823"	2,821.736
T. 33 N., R. 43 E., standard quarter corner of sec. 33; iron section post stamped "2802"	2,800.662
T. 33 N., R. 43 E., standard corner between secs. 33 and 34; iron section post stamped "2908"	2,906.792
T. 33 N., R. 43 E., standard quarter corner of sec. 34; iron section post stamped "2912"	2,910.781
T. 33 N., R. 43 E., standard corner between secs. 34 and 35; iron section post stamped "2925"	2,924.138
T. 33 N., R. 43 E., standard quarter corner of sec. 35; iron section post stamped "2926"	2,924.722
T. 33 N., R. 44 E., standard corner between secs. 35 and 36; iron section post stamped "2936"	2,935.185

Cowan, Glasgow, Larb Creek, Leedy, Malta, and Valleytown Quadrangles.

VALLEY COUNTY.

The elevations in the following list were determined by primary leveling, forming part of a net extending from Fort Benton to the mouth of Milk River, north of Missouri River. Corrections of about 7.5 feet have been added to the original values based upon Malta datum. The values now given accord with Missouri River Commission values at the mouth of Milk River, as published in the 1894 report of the Chief of Engineers, United States Army, but a correction of +4 feet has been applied to the elevation therein published for Kismet.

The leveling by the United States Geological Survey was done in the Cowan quadrangle in 1903 by M. S. Bright; in the Glasgow quadrangle in 1904 by F. E. Fellows; in the Larb Creek quadrangle in 1903 by M. S. Bright and W. P. Flynn, and in 1904 by F. E. Fellows; in the Leedy quadrangle in 1904 by F. E. Fellows; in the Malta quadrangle in 1903 by M. S. Bright and W. P. Flynn, and in

1904 by F. E. Fellows; and in the Valleytown quadrangle in 1903 by M. S. Bright and W. P. Flynn. Additional leveling was done by the Reclamation Service in the Glasgow, Larb Creek, and Malta quadrangles in 1903 and 1904, in the Valleytown quadrangle in 1904, and in the Malta quadrangle in 1902.

COWAN QUADRANGLE.

Iron bridge over Milk River west up Milk River to southeast corner of sec. 9, T. 32 N., R. 32 E., thence up river northwest to Martin's ranch (spur line).

	Feet.
T. 32 N., R. 31 E., 2 miles northwest of S. A. Martin's cabin, 6 feet north of road, 3 feet southeast of witness corner, south bank of Milk River; iron post stamped "2201 MALTA"	2,208.310
Martin's ranch house, 1.5 miles south of, southeast point of bench land, 800 feet northwest of timber, west edge of bottom; iron post stamped "2213 MALTA"	2,220.125

Northeast corner of sec. 4, T. 31 N., R. 32 E., north along section line to T. 33 N., thence east along township line to northeast corner of T. 32 N., R. 32 E.

T. 32 N., R 32 E., NE. ¼ sec. 28, Moraine triangulation station; iron post stamped "2353 MALTA"	2,360.481
T. 32 N., R. 32 E., 2 feet west of southeast corner of sec. 9, 4 feet north of gate; iron post stamped "2194 MALTA"	2,201.156

GLASGOW QUADRANGLE.

Sec. 11, T. 30 N., R. 36 E., southeast along Great Northern Ry. to Whateley.

T. 30 N., R. 37 E., near center of SW. ¼ sec. 18 (unsurveyed), 0.5 mile south of railroad bridge over Ash Coulee, 0.3 mile southwest of northeast end of ridge; iron post	2,281.819
Vandalia, 2 miles south of, about 0.2 mile east of northwest corner of sec. 34, T. 30 N., R. 37 E., 200 feet east of rocky point; iron post	2,222.286
T. 29 N., R. 37 E., near northwest corner of sec. 13 (unsurveyed), near upper end of Hay Coulee, top of ridge, in sheep corral, 1,000 feet west of cabin; iron post	2,223.334
T. 29 N., R. 38 E., near quarter corner on south side of sec. 30, 3.5 miles west of Chris Johnson's house, 300 feet north of Antelope Creek, 400 feet east of sheep corral and log cabin; iron post	2,210.070
Glasgow, 6 miles west of, near quarter corner on east side of sec. 11 (unsurveyed), T. 28 N., R. 38 E., near top of second spur, 1 mile west of Griffiths reservoir; iron post	2,202.562
Glasgow, 5 miles southwest of, southeast of quarter corner on west side of sec. 34, T. 28 N., R. 39 E., 0.5 mile north of Willow Creek, 1.5 miles north of Weatherford's ranch, at station 2238 "M;" iron post	2,186.660
Glasgow, in front of telegraph office; top of rail	2,098.4

Northeast corner of sec. 27, T. 31 N., R. 36 E., southeast along Great Northern Ry. to Glasgow.

Hinsdale, 4 miles northeast of, near center of NW. ¼ sec. 25, T. 31 N., R. 36 E., station 680, 25 feet west of A. Schwartz's east line fence, on slope; iron post stamped "2136 MLT"	2,143.016
Hinsdale, 10 miles southeast of, center of SE. ¼ sec. 3, T. 30 N., R. 37 E., station 786, 1.5 miles south of Beet's ranch, on east bank of Bear Creek; iron post stamped "2127 MLT"	2,134.520

	Feet.
T. 30, R. 37 E., at northeast corner of sec. 24; iron post stamped "2108 MLT"	2,115.421
T. 30 N., R. 38 E., near center of SW. ¼ sec. 20, station 880, 30 feet south of main Glasgow road, 3 feet inside of Wm. Demessemacker's north line fence; iron post stamped "2115 MLT"	2,122.498
Glasgow, 7 miles northwest of, about 0.2 mile west of center sec. 14, T. 29 N., R. 38 E., 100 feet northwest of W. B. Dolson's house, 50 feet south of main road, northwest corner of fence, 200 feet north of Milk River, at station 990+150; iron post stamped "2101 MLT"	2,108.100
Glasgow, 2.5 miles northwest of, 700 feet south of northwest corner of sec. 33, T. 29 N., R. 39 E., 400 feet south of station 1093, beside main road, on fence line, 0.5 mile east of shearing plant; iron post stamped "2091 MLT"	2,098.365
Glasgow, 0.5 mile northwest of courthouse, 850 feet south of northwest corner sec. 11, T. 28 N., R. 39 E., on west side of main road, on fence line; iron post stamped "2089 MLT"	2,096.557
Glasgow, north side of courthouse, in foundation, east of stone steps; aluminum tablet stamped "2088 MLT"	2,095.072

Hinsdale southeast to sec. 26, T. 28 N., R. 39 E.

T. 29 N., R. 38 E., center of south side of SW. ¼ sec. 30, station 3391, on north bank of Antelope Creek, 150 feet west of Chris Johnson's stable; iron post stamped "2139 MLT"	2,147.063
Glasgow, 7.5 miles west of, NW. ¼ sec. 24 (unsurveyed), T. 28 N., R. 38 E., station 4006, 325 feet north of Brazil Creek, 200 feet east of Frank Miller's log cabin; iron post stamped "2126 MLT"	2,133.794
Glasgow, 3 miles southwest of, sec. 21, T. 28 N., R. 39 E., station 4298, 100 feet west of main road running southwest across the hills; iron post stamped "2121 MLT"	2,128.806
Glasgow, 3 miles south of, sec. 26, T. 28 N., R. 39 E., station 4553, at west side of mouth of Willow Creek Valley (end of "A" line) on spur of ridge; iron post stamped "2116 MLT"	2,123.865

Northeast corner of sec. 34, T. 31 N., R. 36 E., southeast between north and south Bowdoin Canal projects to Glasgow.

Hinsdale, 6.2 miles east of, 45 feet southwest of northeast corner of sec. 1, T. 30 N., R. 36 E., side of wire fence, 200 feet northwest of house; iron post stamped "2128 MALTA"	2,135.257
Hinsdale, 9.5 miles east of, about center of NE. ¼ NW. ¼ sec. 10, T. 30 N., R. 37 E., north side of road, 3 feet east of gatepost; iron post stamped "2119 MALTA"	2,126.433
Hinsdale, 12.8 miles southeast of, 1 foot north of southeast corner of sec. 13, T. 30 N., R. 37 E., 0.2 mile southeast of E. L. Cain's house, 1,000 feet south of reservoir dam; iron post stamped "2108 MALTA"	2,115.421
Hinsdale, 16.2 miles southeast of, center of NW. ¼ sec. 33, T. 30 N., R. 38 E., 0.2 mile southeast of schoolhouse, 200 feet southwest of road junction, 900 feet north of Milk River, 100 feet west of slough, 10 feet east of road, 8 feet east of gatepost; iron post stamped "2106 MALTA"	2,113.530
Tampico, 3.8 miles southeast of, 1.5 feet south of northeast corner of sec. 21, T. 29 N., R. 38 E., 2,000 feet west of Great Northern Ry. bridge 389, 250 feet south of wire fence; iron post stamped "2099 MALTA"	2,106.524
Tampico, 8 miles southeast of, 1.5 feet north of southeast corner of sec. 36, T. 29 N., R. 38 E., 15 feet south of wire fence, 200 feet south of irrigation ditch, in slough; iron post stamped "2090 MALTA"	2,097.543

	Feet.
Glasgow, 3 miles southwest of, 3 feet south of northeast corner of sec. 16, T. 28 N., R. 39 E., 700 feet southwest of main road; iron post stamped "2087 MALTA"	2,094.569
Glasgow, 0.5 mile north of, west side of road, 3 feet east of wire fence; iron post stamped "2089 MALTA"	2,096.582

Point on "M" line west of Vandalia to Glasgow.[1]

Tampico, 1.5 miles northwest of, Tampico triangulation station, 200 feet south of Great Northern Ry.; iron post stamped "2178 MALTA"	2,185.657

Point on "M" line south of Glasgow east and southeast to T. 28 N., R. 40 E.

Glasgow, 4 miles southeast of, 255 feet south of northeast corner of sec. 36, T. 28 N., R. 39 E., 40 feet west of one and 60 feet east of other of two sloughs, 350 feet north of Willow Creek; iron post stamped "2082 MALTA"	2,089.547
Glasgow, 5.5 miles southeast of, 2 feet east of southwest corner of sec. 34, T. 28 N., R. 40 E., 300 feet south of road; iron post stamped "2075 MALTA"	2,082.511

LARB CREEK QUADRANGLE.

Sec. 11, T. 30 N., R. 33 E., down south side of Bowdoin Creek and Beaver Creek valley to sec. 11, T. 30 N., R. 36 E.

Saco, 3.5 miles west of, near center of sec. 3, T. 31 N., R. 33 E., near second post west of milepost 320, 300 feet south of track; iron post	2,241.089
Saco, 1 mile southwest of, near center of NW. ¼ sec. 18, T. 31 N., R. 34 E., on side hill near station "824 M;" iron post	2,239.590
Saco, 3 miles southeast of, near quarter corner between secs. 27 and 28, T. 31 N., R. 34 E., on ridge 500 feet north of mouth of creek, 1 mile east of William Taylor's ranch; iron post	2,257.408
T. 30 N., R. 34 E., 0.2 mile north of SE. ¼ sec. 9 (unsurveyed), 0.7 mile south of Second Creek, on first flat wash; iron post	2,234.676
T. 30 N., R. 34 E., west side of NW. ¼ sec. 11, 0.5 mile east of Second Creek, 500 feet north of bend in creek on top of spur; iron post	2,227.645
T. 31 N., R. 35 E., near center of SW. ¼ sec 30, 1 mile east of mouth of Larb Creek, 0.5 mile southeast of Great Northern Ry. bridge; iron post	2,229.536
Hinsdale, 2.5 miles west of, northeast corner of sec. 2, T. 30 N., R. 35 E.; iron post	2,233.741
Hinsdale, 1 mile southeast of, northeast corner of sec. 8, T. 30 N., R. 36 E.; iron post	2,225.935
Hinsdale, 5 miles east of, about 0.2 mile east of center sec. 11, T. 30 N., R. 36 E., 0.2 mile east of railroad crossing, 50 feet north of road, on top of hill; iron post	2,254.822

McCreary's ranch at "M" canal line east along road 13 miles, thence north 6 miles to "M" canal line at Otto Able's ranch.

McCreary's ranch, 6.2 miles east of, on mesa 0.5 mile south of coulee, 20 feet west of road; iron post stamped "2625 MALTA"	2,632.500
McCreary's ranch, 9.2 miles east of, top of broken divide 400 feet west of north-south road; iron post stamped "2712 MALTA"	2,719.780
Roach sheep ranch, 1.2 miles north of, on ridge extending northwest and southeast, 12 feet west of old road; iron post stamped "2617 MALTA"	2,624.500

[1] This line is connected at several other points with the "M" and South Bowdoin Canal lines of the Reclamation Service, and establishes the elevations of many temporary bench marks in addition to the one standard bench mark here listed.

	Feet.
Box house in coulee, 1.8 miles north of, north point of ridge, south side of coulee, at angle in road to east; iron post stamped "2457 MALTA"	2,464.454
From "M" line canal east along highway to Larb Creek (Otto Able's ranch).	
Tucker's sheep ranch, 600 feet west of, 30 feet north of road, 50 feet north of coulee; iron post stamped "2417 MALTA"	2,425.302
Tucker's sheep ranch, 2.5 miles northeast of, 2 miles northwest of DK ranch, in road forks; iron post stamped "2802 MALTA"	2,810.220
Otto Able's ranch house, 3.8 miles west of, west entrance to pasture, 16 feet south of gate and road; iron post stamped "2342 MALTA"	2,350.129
T. 30 N., R. 34 E., in west half of sec. 22, 0.5 mile west of Otto Able's ranch house, 300 feet north of "M" canal station 1053, at fence corner, east of road; iron post stamped "2225 MALTA"	2,232.516
Otto Able's ranch, T. 30 N., R. 34 E., east along highway to point near center of T. 30 N., R. 36 E., thence north to Hinsdale.	
T. 30 N., R. 35 E., in west side of unsurveyed township, 2.2 miles east of Otto Able's ranch house, 0.5 mile south of Powell's sheep sheds, south spur of ridge; iron post stamped "2535 MALTA"	2,542.557
T. 30 N., R. 35 E., 2 feet east of quarter corner on south side of sec. 16, 800 feet east of A. W. Powell's stone house; iron post stamped "2596 MALTA"	2,603.415
T. 30 N., R. 35 E., 550 feet east of southwest corner of sec. 12, top of ridge; iron post stamped "2792 MALTA"	2,799.357
Hinsdale, 2 miles southeast of, 12 feet west of A. D. Kepple's ranch house, beside wire fence; iron post stamped "2470 MALTA"	2,477.424
Hinsdale, 1.5 miles southeast of, southwest corner of sec. 4, T. 30 N., R. 36 E.; iron post	2,225.935
Saco along highway east and north to river near Tanner's ranch.	
Saco, 2.5 miles east of, near quarter corner on north side of sec. 15, T. 31 N., R. 34 E., 10 feet south of road fork, 2 feet west of fence corner post; iron post stamped "2178 MALTA"	2,185.248
Saco, 6.2 miles east of, near center of SW. ¼ sec 18, T. 31 N., R. 35 E., 500 feet west of small coulee, top of flat ridge, north of dry lake; iron post stamped "2190 MALTA"	2,197.126
Northeast corner of sec. 1, T. 31 N., R. 32 E., east along township line to sec. 5, T. 31 N., R. 36 E., thence south to Hinsdale.	
T. 31 N., R. 33 E., northwest corner of sec. 6, 0.8 mile west of Beaver Creek, on Bradys Meadow; iron post stamped "2193 MALTA"	2,200.072
T. 31 N., R. 33 E., northwest corner of sec. 3, 1 mile west of north-south line fence on Gumbo flat; iron post stamped "2186 MALTA"	2,193.003
T. 31 N., R. 34 E., northwest corner of sec. 6, at intersection of 4 fences; iron post stamped "2177 MALTA"	2,184.078
T. 31 N., R. 34 E., quarter corner on north side of sec. 3, 700 feet east of wagon trail from Saco; iron post stamped "2264 MALTA"	2,271.066
T. 32 N., R. 35 E., southwest corner of sec. 31, on hill sloping west, 3.2 miles west of Milk River, 4 feet north of section corner stone; iron post stamped "2247 MALTA"	2,253.968
T. 32 N., R. 35 E., 6 feet north of southeast corner of sec. 33, 2,600 feet southeast of Tanner's house, 2,000 feet west of Milk River, in Tanner's field; iron post stamped "2155 MALTA"	2,161.898

	Feet.
T. 31 N., R. 36 E., northwest corner of sec. 6, on hill, 300 feet west of section corner; iron post stamped "2299 MALTA"	2,305.882
T. 31 N., R. 36 E., 5 feet south of quarter corner on north side of section 8; iron post stamped "2187 MALTA"	2,193.924
T. 31 N., R. 36 E., 60 feet northeast of southwest corner of sec. 16, on south side of county road; iron post stamped "2220 MALTA"	2,226.918
T. 30 N., R. 36 E., southeast corner of sec. 5, near canal line; iron post stamped "2219 MALTA"	2,225.913

Northeast corner of sec. 28, T. 32 N., R. 33 E., east to northeast corner of sec. 27, T. 31 N., R. 36 E.

Saco, 2.5 miles north of, sec. 32, T. 32 N., R. 34 E., station 290, in field, 0.5 mile east of A. Blue's old house; iron post stamped "2179 MLT"	2,186.485
T. 31 N., R. 34 E., at quarter corner on south side sec. 10; iron post stamped "2178 MLT"	2,185.248
T. 31 N., R. 34 E., sec. 24, station 430, 0.8 mile north of Beaverton siding on Great Northern Railway; iron post stamped "2170 MLT"	2,176.706
Hinsdale, 5 miles northwest of, center of SE. ¼ sec. 10, T. 31 N., R. 35 E., 160 feet east of S. Drabb's house, at northwest corner of hay corral; iron post stamped "2158 MLT"	2,164.911
Hinsdale, 2 miles north of, near quarter corner on east side of sec. 20, T. 31 N., R. 36 E., 100 feet northeast of station 610, at northwest corner of J. Janssen's yard; iron post stamped "2145 MLT"	2,151.686
T. 31 N., R. 36 E., northeast corner of sec. 27; iron post stamped "2137 MLT"	2,144.642

Sec. 30, T. 31 N., R. 35 E., to Hinsdale.

T. 31 N., 35 E., NW. ¼ sec 30, station 1136 + 50, 0.8 mile east of Beaverton siding, 400 feet east of Beaver Creek railroad bridge; iron post stamped "2173 MLT"	2,180.355
Hinsdale, in front of telegraph office; top of inside rail	2,185.8

Southwest corner of sec. 31, T. 31 N., R. 35 E., north 3 miles, thence west 3 miles, and north 3 miles to northeast corner of sec. 4, T. 31 N., R. 35 E.

Hinsdale, 4 miles northwest of, southeast corner of sec. 13, T. 31 N., R. 35 E., north side of Milk River, 1,200 feet west of house; iron post stamped "2144 MALTA"	2,151.991
Hinsdale, 7 miles northwest of, 45 feet northwest of southeast corner of sec. 16, T. 31 N., R. 35 E., 30 feet north of corner of wire fence; iron post stamped "2151 MALTA"	2,158.600
Hinsdale, 10 miles northwest of, 6 feet north of southeast corner of sec. 33, T. 32 N., R. 35 E., 0.5 mile southeast of Tanner's house, 0.5 mile southwest of Milk River; iron post stamped "2155 MALTA"	2,161.898

Point 1.5 miles northeast of Hinsdale east to northeast corner of sec. 34, T. 31 N., R. 36 E., thence by spur line north 5 miles.

Hinsdale, 2.5 miles northeast of, 30 feet east of southwest corner of sec 27, T. 31 N., R. 36 E., 0.2 mile south of schoolhouse, 250 feet northwest of Hanson's wire fence; iron post stamped "2137 MALTA"	2,144.722
Hinsdale, 5.5 miles northeast of, 1 foot south of northeast corner of sec. 22, T. 31 N., R. 36 E., iron post stamped "2165 MALTA"	2,172.382
Hinsdale, 8.5 miles northeast of, northwest corner of sec. 2, T. 31 N., R. 36 E., 1,700 feet north by 1,000 feet west of Rock Creek; iron post stamped "2164 MALTA"	2,171.031

LEEDY QUADRANGLE.

Point near center of T. 26 N. southwest along west side of Sun Prairie Creek to Missouri River.

	Feet.
Sun Prairie Creek, 1,000 feet north and 1,000 feet west of, 0.8 mile southeast of mouth of coulee, top of small butte; iron post stamped "2331 MALTA"	2,338.5
Sun Prairie Creek, 0.5 mile northwest of bridge, northwest edge of valley, 120 feet west of road; iron post stamped "2335 MALTA"	2,342.5
Sun Prairie Creek, 0.5 mile south of, 0.2 mile east of west edge of valley, top of east end of slight ridge; iron post stamped "2353 MALTA"	2,360.6
Sun Prairie Creek, 3.8 miles south of, 190 feet south of lone willow tree, 175 feet south of First Creek, 50 feet south of unfinished log cabin, in pasture; iron post stamped "2348 MALTA"	2,355.5
Telegraph Creek, 1 mile west of, west edge of valley, corner of wire fence, 300 feet south of board cabin, 20 feet west of road, 10 feet west of gate; iron post stamped "2344 MALTA"	2,351.5
Telegraph Creek, 900 feet west of, 100 feet west of slough, in center of valley, 0.8 mile northeast of Third Creek, 6 feet east of road; iron post stamped "2313 MALTA"	2,320.6
Telegraph Creek, 0.2 mile west of, 700 feet south of slough, 0.2 mile west of log cabin, 15 feet east of road; iron post stamped "2292 MALTA"	2,299.6
Long X ranch house, 250 feet west of, 600 feet southeast of Fourchette Creek, 10 feet west of wire fence gate and road; iron post stamped "2298 MALTA"	2,305.6
Long X ranch, 3.8 miles southwest of, 600 feet southwest of mouth of coulee, 500 feet north of Valentine Creek, 1.5 miles south of Fourchette Creek, in Valentine Creek valley; iron post stamped "2356 MALTA"	2,363.6
Long X ranch, 8 miles southwest of, 700 feet northwest of ridge in valley, southeast side wire fence, 6 feet east of gate and road; iron post stamped "2350 MALTA"	2,357.6
T. 21 N., R. 30 E., 8 feet northwest of corner of section 4, 3.5 miles north of Maginnis ranch, 180 feet west of road, 500 feet northwest of gate and wire fence, 800 feet east of west edge of valley, 0.2 mile west of Jim Wells Creek; iron post stamped "2335 MALTA"	2,342.6
Maginnis ranch, 0.5 mile northeast of, 30 feet east of road, 130 feet south of creek, 800 feet east of reservoir dam site, east edge of valley; iron post stamped "2228 MALTA"	2,235.6
Latitude 47° 29′ 44.39″, longitude 107° 53′ 40.62″, 4.2 miles above mouth of Musselshell River, 650 feet east of left bank of Missouri River, 30 feet south of mouth of coulee, 0.2 mile north of Maginnis ranch, 20 feet west of road, at side of wire fence; iron post stamped "Missouri River Commission B. M. 68.2;" Missouri River Commission bench mark 68/2 plotted on chart 64.	
Bolt underground	2,218.4
Top of cap of post	2,222.6

MALTA QUADRANGLE.

Malta west up south side of Milk River to water tank dam site.

Malta, 2.5 miles southwest of, 10 feet northwest of Phillips road; iron post stamped "2258"	2,264.3
Malta, 4.5 miles west of, 1.5 miles south of Malta road, station 98A of canal line; iron post stamped "2261"	2,267.2

Exeter east along Great Northern Ry. to Malta.

	Feet.
Exeter, 4 feet west of station sign; iron post	2,263.242

Point near Exeter northeast to mouth of Assinniboine Creek (single spur line).

Malta, 6.5 miles northeast of, sec. 22, T. 31 N., R. 30 E., near mouth of Assinniboine Creek, in southwest corner of fence of "Circle Diamond" ranch; iron post	2,247.295

Malta east to west end of Bowdoin Lake.

Malta, in front of telegraph station; top of rail	2,257.9
Malta, northeast corner of schoolhouse foundation; bronze tablet	2,266.618
Malta, sec. 22, T. 30 N., R. 30 E., 3.5 miles east of, 300 yards southeast of Morton's ranch, at "Camp Morton," iron post	2,275.392
Malta, sec. 12, T. 30 N., R. 30 E., 6 miles east of, northwest corner of Tucker's fence line; iron post	2,258.370

Sec. 6, T. 30 N., R. 30 E., northeast around Bowdoin Lake to point near Ashfield, thence southwest along Great Northern Ry. to Bowdoin Lake.

T. 31 N., R. 31 E., 400 feet south of northwest corner of sec. 28, 0.5 mile northwest of Bowdoin Lake, 9 miles northeast of Malta, at station 73; iron post	2,262.300
T. 31 N., R. 31 E., near northwest corner of sec. 24, 1.5 miles northeast of Bowdoin Lake; iron post	2,258.254
Ashfield, NE. ¼ sec. 27, T. 31 N., R. 32 E., 1.3 miles west of, station 214; iron post	2,265.212

Point on "M" canal line northwest to "B" canal line.

Ashfield, 60 feet southeast of water tank; iron post	2,213.193

Point on "B" canal line south around Bowdoin Lake.

Bowdoin Lake; surface of water, Oct. 7, 1903	2,211.8
T. 30 N., R. 31 E., near center of NW. ¼ sec. 15, 1 mile due south of Bowdoin section house, station 66 "E"; iron post stamped "2225"	2,232.113

Point on "E" canal line east to Great Northern Ry., thence southwest to station 86 K.

T. 30 N., R. 32 E., sec. 5, station 62, 70 feet south of track; iron post stamped "2227"	2,234.349
T. 30 N., R. 32 E., center of SE. ¼ sec. 7, station 86 K, 700 feet west of stone cabin; iron post	2,233.858

Morton's ranch down south side of Bowdoin Valley to Circle Diamond dam.

T. 30 N., R. 31 E., 400 feet southwest of northeast corner of sec. 25, station 254 "M," 0.5 mile west of yellow house and windmill; iron post	2,256.809
T. 29 N., R. 32 E., 0.2 mile west of northeast corner of sec. 7, first ranch north of Sanford's reservoir, 0.8 mile north of Sanford's residence, 700 feet south of northwest corner of fence, 30 feet west of road; iron post	2,252.844
T. 29 N., R. 32 E., near center of NW. ¼ sec. 22, at station 432 "M," east of small frame house, 300 feet east of corner of fence; iron post	2,250.123
T. 29 N., R. 32 E., 0.2 mile southwest of center of sec. 4, 0.3 mile east of Beaver Creek, on point of spur; iron post	2,251.225
T. 30 N., R. 32 E., 400 feet south of northeast corner of sec. 21, 1 mile southeast of Circle Diamond dam, near Tucker's ranch, 200 feet east of fence, on point of spur; iron post	2,247.986
T. 30 N., R. 32 E., 0.3 mile north of southwest corner of sec. 11, 1.5 miles northeast of Circle Diamond dam, 2 miles northeast of Tucker's ranch, 20 feet west of road to Saco, 100 feet east of fence; iron post	2,248.684

Bowdoin Lake south along section lines in R. 31 E., thence east 6 miles and northwest 20 miles to dam across coulee.

	Feet.
T. 30 N., R. 31 E., 65 feet north of southwest corner of sec. 34; iron post stamped "2456 MALTA"	2,463.3
T. 29 N., R. 31 E., 0.25 mile south of northeast corner of sec. 21, at top of ridge; iron post stamped "2632 MALTA"	2,639.13
T. 28 N., R. 31 E., sec. 4, 1 foot south of stone corner at northeast corner; iron post stamped "2660 MALTA"	2,667.19
T. 28 N., R. 31 E., 220 feet south of northeast corner of sec. 22; iron post stamped "2593 MALTA"	2,599.99
T. 27 N., R. 31 E., 1 foot southwest of northeast corner of sec. 3; iron post stamped "2501 MALTA"	2,507.90
Frank Rudy's old sheep ranch, 0.2 mile east of; iron post stamped "2525 MALTA"	2,531.89
Rudy's lower sheep ranch, 2,000 feet southwest of, 585 feet south of Beaver Creek, 100 feet west of canal line; iron post stamped "2352 MALTA"	2,359.040
Beaver Creek, 2.5 miles south of, 200 feet south of creek bottom, top of small butte; iron post stamped "2410 MALTA"	2,416.854
South Beaver Creek, 1.8 miles west of, west edge of valley, at foot of hills; iron post stamped "2315 MALTA"	2,322.003
Miller's ranch, 4.2 miles south of, 1 mile east of creek, top of slight ridge; iron post stamped "2332 MALTA"	2,339.000
Miller's ranch, 1.2 miles south of, 130 feet west of fence corner; iron post stamped "2296 MALTA"	2,303.139
Miller's ranch, 0.8 mile north of, 0.2 mile south of dam, 17 feet west of ford on Beaver Creek; iron post stamped "2282 MALTA"	2,289.016
Miller's ranch, 4 miles north of, 0.5 mile south of new house, 12 feet north of lone tree, 0.2 mile west of creek, 50 feet north of slough; iron post stamped "2270 MALTA"	2,276.899
T. 28 N., R. 32 E., near southwest corner of sec. 18, in open flat, 0.5 mile west of creek, 0.5 mile east of road; iron post stamped "2260 MALTA"	2,266.790
Canal line, 1.5 miles south of, 1,800 feet west of Beaver Creek, south bank of slough, 4 feet east of road; iron post stamped "2248 MALTA"	2,254.774
McCreary's ranch house, 0.8 mile northwest of, 400 feet southwest of canal station 374, 500 feet west of creek and 20 feet west of road, in small valley; iron post stamped "2243 MALTA"	2,249.649

McCreary's ranch east along road 3 miles.

McCreary's ranch, 3 miles east of, 100 feet south of road, south side of coulee, point of ridge; iron post stamped "2402 MALTA"	2,409.491

Point 9 miles northeast of "B" canal line north and east along township line to northeast corner of T. 31 N., R. 32 E.

T. 32 N., R. 31 E., 4 feet north of quarter corner on south side of sec. 33, 100 feet east of road; iron post stamped "2391 MALTA"	2,398.425
T. 32 N., R. 31 E., 6 feet north of southeast corner of sec. 36, on flat southeast of Lone Tree Lake; iron post stamped "2114 MALTA" (stamped wrong)	2,221.019
T. 31 N., R. 32 E., northwest corner sec. 3, about 2,700 feet east of lake, on top of hill; iron post stamped "2223 MALTA"	2,230.12

Ashfield southwest along south side of Great Northern Ry. to northeast end of Brady reservoir dam.

T. 31 N., R. 32 E., 1,630 feet southwest from northeast corner of sec. 34, at northeast end of proposed Bowdoin dam, on knoll; iron post stamped "2246 MLT"	2,253.282

Ashfield north to sec. 36, T. 32 N., R. 32 E. (Bowdoin North canal).

	Feet.
T. 31 N., R. 32 E., 635 feet northwest of southeast corner of sec. 15, 1 mile northwest of Ashfield, station 66, on north side of slough; iron post stamped "2201 MLT"	2,208.066
T. 32 N., R. 32 E., 1,957 feet northeast of southwest corner of sec. 36, station 144; iron post stamped "2193 MLT"	2,200.081

VALLEYTOWN 30′ QUADRANGLE.

Southwest corner of sec. 32, T. 32 N., R. 34 E., north along section line to iron bridge across Milk River, thence east down north side of Milk River to south side of T. 31 N., R. 32 E., near Tanner's ranch.

T. 32 N., R. 34 E., near northwest corner of sec. 18, 300 feet south of iron bridge, 150 feet south of road, in granite outcrop; aluminum tablet stamped "2192 MALTA"	2,199.101
T. 32 N., R. 34 E., about 0.1 mile west of center of SW. ¼ sec. 14, 0.5 mile west of Davis ranch, 3 feet south of road, at gate in corner of wire fence; iron post stamped "2174 MALTA"	2,181.146
T. 32 N., R. 35 E., 0.3 mile east of center of sec. 20, 0.3 mile north of Grove's ranch house, 300 feet northwest of round lake (dry), 3 feet west of road; iron post stamped "2162 MALTA"	2,169.190

Northeast corner of sec. 1, T. 32 N., R. 32 E., east along township line to sec. 5, T. 32 N., R. 36 E., thence south and west to southwest corner of T. 32 N., R. 36 E.

T. 32 N., R. 32 E., northeast corner of sec. 1, closing corner; iron post stamped "2278 MALTA"	2,285.272
T. 32 N., R. 33 E., 200 feet east of closing corner at northwest corner of sec. 3, in coulee, 5 feet east of road; iron post stamped "2251 MALTA"	2,258.270
T. 32 N., R. 33 E., closing corner at northeast corner of sec. 1; iron post stamped "2324 MALTA"	2,331.272
T. 32 N., R. 34 E., 90 feet east of northwest corner of sec. 31, closing corner; iron post stamped "2333 MALTA"	2,339.718
T. 32 N., R. 35 E., 700 feet east of northwest corner of sec. 6, closing corner at top of bluff; iron post stamped "2392 MALTA"	2,399.800
T. 32 N., R. 35 E., 0.4 mile west of closing corner of northeast corner of sec. 2, on line, at top of ridge; iron post stamped "2594 MALTA"	2,600.814
Rock Creek triangulation station, about 700 feet southwest of quarter corner on east side of sec. 35, T. 33 N., R. 35 E.; iron post stamped "2722 MALTA"	2,729.264
T. 32 N., R. 36 E., 800 feet north of quarter corner on east side of sec. 5, 1,000 feet south of flat draw; iron post stamped "2478 MALTA"	2,484.884
T. 32 N., R. 36 E., 600 feet north of quarter corner on east side of sec. 29; iron post stamped "2411 MALTA"	2,417.820

T. 32 N., R. 32 E., east and southeast to sec. 28, T. 32 N., R. 33 E.

T. 32 N., R. 33 E., 1,630 feet south of northeast corner of sec. 28, station 220; iron post stamped "2185 MLT"	2,192.486

Avery, Bearpaw Mountains, Cherry Ridge, Dodson, Gildford, Hays, Lonesome Lake, Soose Mountains, Thibedeau Lake, and Zurich Quadrangles.

CHOUTEAU COUNTY.

The elevations in the following list were determined by primary leveling forming part of a net extending from Fort Benton to the mouth of Milk River north of Missouri River. To the original values

referred to Havre datum corrections of about 6 feet have been added. The values now given are believed to accord with those computed in 1911 for Butte on the Coast and Geodetic Survey precise level line. The Missouri River Commission elevations, as published in the 1894 Report of the Chief of Engineers, are accepted without correction east of Milk River in Montana, but between Milk River and Kismet there is a probable discrepancy of 4 feet. Therefore, between Kismet and Fort Benton 4 feet has been added to the values therein given.

The leveling by the United States Geological Survey was done in the Avery quadrangle in 1903 by M. S. Bright; in the Bearpaw Mountains quadrangle in 1902 by M. S. Bright and J. T. Stewart, and in 1904 by L. H. Brady; in the Cherry Ridge quadrangle in 1902 by M. S. Bright and H. F. Burkhart, in 1903 by M. S. Bright and H. F. Daniels, in 1909 by W. R. Winstead, and in 1910 by A. C. Leonard; in the Dodson quadrangle in 1903 by M. S. Bright and H. F. Daniels; in the Gildford quadrangle in 1902 by H. F. Burkhart, and in 1904 by L. H. Brady; in the Hays quadrangle in 1903 by H. F. Daniels; in the Lonesome Lake quadrangle in 1904 by L. H. Brady, Fred McLaughlin, J. O. Watts, and H. L. Baldwin; in the Soose Mountains quadrangle in 1904 by Fred McLaughlin; additional leveling was done in the Cherry Ridge, Dodson, Hays, Lonesome Lake, and Soose Mountains quadrangles in 1904, and in the Lonesome Lake, Soose Mountains, Thibedeau Lake, and Zurich quadrangles in 1903, by the Reclamation Service; in Thibedeau Lake quadrangle in 1902 by M. S. Bright and H. F. Burkhart, and in 1909 by W. R. Winstead; and in the Zurich quadrangle in 1902 by M. S. Bright and H. F. Burkhart.

AVERY QUADRANGLE.

Southeast corner of T. 33 N., R. 24 E., east along standard parallel to southeast corner of T. 33 N., R. 26 E., thence south to southwest corner of Sec. 19, T. 32 N., R. 27 E.

	Feet.
T. 33 N., R. 25 E., standard corner of secs. 31 and 32; stone	2,699.93
T. 33 N., R. 25 E., standard corner of secs. 32 and 33; stone	2,766.55
T. 33 N., R. 25 E., southeast corner of; stone	2,856.69
T. 33 N., R. 25 E., standard corner of secs. 35 and 36; stone	2,867.70
T. 33 N., Rs. 25 and 26 E., 300 feet west of standard corner of, at top of ridge; iron post stamped "2876 HAVRE"	2,882.452
T. 33 N., R. 26 E., standard corner of secs. 31 and 32; stone	2,785.38
T. 33 N., R. 26 E., standard corner of secs. 32 and 33; stone	2,857.79
T. 33 N., R. 26 E., standard corner of secs. 33 and 34, 2 feet east of stone; iron post stamped "2865 HAVRE"	2,871.627
T. 33 N., R. 26 E., standard corner of secs. 34 and 35; stone	2,841.62
T. 32 N., R. 26 E., standard corner of secs. 1 and 2; stone	2,876.81
T. 33 N., Rs. 26 and 27 E., standard corner of, 1 foot east of stone; iron post stamped "2806 HAVRE"	2,812.626
T. 32 N., R. 27 E., 1 mile south of standard parallel, top of sharp ridge; pain[illegible] point on bowlder outcrop	2,820.54

	Feet.
T. 32 N., Rs. 26 and 27 E., 400 feet south of corner of secs. 13, 18, 19, and 24; iron post stamped "2677 HAVRE"	2,683.874
T. 32 N., Rs. 26 and 27 E., at corner of secs. 19, 24, 25, and 30; stone	2,639.27

BEARPAW MOUNTAINS QUADRANGLE.

Sec. 34, T. 32 N., R. 13 E., east and south to Box Elder.

T. 31 N., R. 13 E., southwest corner of sec. 1; iron post stamped "2800 HAVRE"	2,805.868
T. 31 N., R. 13 E., southwest corner of sec. 24; iron post stamped "2759 HAVRE"	2,764.854
T. 30 N., R. 13 E., southwest corner of sec. 1; iron post stamped "2639 HAVRE"	2,644.770

Sec. 25, T. 32 N., R. 16 E., southeast and northeast to point 1.5 miles south of Bice's coal mine.

T. 32 N., R. 17 E., 1.5 miles south of Bice's coal mine, on road from Havre to Stanton's coal mine, in first coulee west of Little Box Elder Creek, on knoll; iron post stamped "2827 HAVRE"	2,832.993

CHERRY RIDGE 30′ QUADRANGLE.

Northwest corner of sec. 4, T. 34 N., R. 21 E., east and south along township and section lines to Harlem.

Tps. 34 and 35 N., R. 21 E., 300 feet west of quarter corner between secs. 3 and 34, on west bank of Parallel Creek; iron post stamped "2854 HAVRE"	2,860.206
Tps. 34 and 35 N., R. 22 E., 0.2 mile west of corner of secs. 5, 6, 31, and 32, on top of ridge; iron post stamped "2955 HAVRE"	2,961.162
Tps. 34 and 35 N., R. 22 E., 900 feet northeast of quarter corner between secs. 2 and 35, on top of flat butte, 500 feet north of line; iron post stamped "3299 HAVRE"	3,305.386
T. 34 N., Rs. 22 and 23 E., 50 feet south of corner of secs. 7, 12, 13, and 18, on line; iron post stamped "3196 HAVRE"	3,202.385
T. 34 N., R. 22 E., 325 feet north of southeast corner of, at summit of ridge; iron post stamped "2881 HAVRE"	2,887.369
T. 33 N., Rs. 22 and 23 E., 890 feet south of quarter corner between secs. 13 and 18, on top of ridge; iron post stamped "2701 HAVRE"	2,707.229
T. 33 N., R. 23 E., 650 feet north of southwest corner of, on top of flat ridge; iron post stamped "2640 HAVRE"	2,646.379

Harlem west along Great Northern Ry. to Zurich.

Harlem, northeast corner of New England Hotel, at edge of sidewalk; iron post stamped "2366 HAVRE"	2,372.496
Harlem, 3.2 miles west of, 250 feet southwest of milepost 391, south side of public road, 4 feet east of gate; iron post stamped "2356 HAVRE"	2,362.451
Madras siding, 40 feet north of railroad track and 20 feet west of wagon road, near telegraph pole; iron post stamped "2365 HAVRE"	2,371.393
Harlem, 9.2 miles west of, at milepost 397, 50 feet south of track, at north side of wagon road, near wire fence; iron post stamped "2372 HAVRE"	2,378.383

Sec. 33, T. 34 N., R. 21 E., east along township line to range line between Rs. 22 and 23.

T. 34 N., R. 21 E., 350 feet west of southeast corner of sec. 33; iron post stamped "2722 HAVRE"	2,728.121

	Feet.
T. 34 N., R. 22 E., 120 feet north of southeast corner of sec. 31; iron post stamped "2737 HAVRE"	2,743.183
T. 34 N., R. 22 E., 500 feet east of southeast corner of SW. ¼ sec. 34, on prominent knoll; iron post stamped "2791 HAVRE"	2,797.143

Harlem south and west along township and section lines to southeast corner of sec. 22, T. 32 N., R. 21 E.

T. 32 N., R. 22 E., southeast corner of sec. 24, 5 feet north of fence corner; iron post stamped "2344 HAVRE"	2,350.429
T. 32 N., R. 22 E., 60 feet east of southeast corner of sec. 20; iron post stamped "2421 HAVRE"	2,427.335
T. 32 N., R. 21 E., 250 feet south of southeast corner of sec. 22, on top of prominent knoll; iron post stamped "2580 HAVRE"	2,586.414

Harlem east along Great Northern Ry. 5 miles.[1]

Harlem, east of station, in corner post of fence directly south of cattle guard; spike on south side	2,365.53
Harlem, 50 feet south of third cattle guard east of station; end of iron post at southwest corner of wire fence	2,356.98
Harlem, 1.6 miles east of, in north side of bridge over Noon Creek; end of projecting plank	2,357.27
Harlem, 2 miles east of, south side of right of way; nail in tenth fence post east of crossing	2,353.14
Harlem, 3 miles east of, 50 feet south of right of way, east of post in wire fence; iron post stamped "2342 HAVRE"	2,348.302
Harlem, 4 miles east of, 250 feet west of milepost, south side of right of way; spike in fence post	2,338.43
Harlem, 5 miles east of, 100 feet west of crossroads, south of right of way; spike in signal post	2,332.14
Montauk, 75 feet east of trestle 531, south of right of way; iron post stamped "2323 HAVRE"	2,329.089

Sec. 8, T. 32 N., R. 21 E., southeast to vicinity of sec. 23, T. 32 N., R. 22 E.

Harlem, 8 miles southwest of, sec. 14, T. 32 N., R. 21 E., 100 feet east of telephone line, station 720; iron post stamped "2374 HAVRE"	2,379.961
Fort Belknap, 2.5 miles northwest of, Reclamation Service canal survey station 1167, 6 feet south of main hill road; iron post stamped "2364 HAVRE"	2,370.222

Southeast corner of T. 34 N., R. 22 E., east to southeast corner of sec. 33, T. 34 N., R. 23 E., thence north to T. 35 N., thence west along north boundary of T. 34 N. to southeast corner of T. 35 N., R. 22 E.

Tps. 33 and 34 N., Rs. 22 and 23 E., corner of; iron post stamped "2881 HAVRE"	2,887.369
Tps. 33 and 34 N., R. 23 E., at corner of secs. 5, 6, 31, and 32; stone	2,807.296
Tps. 33 and 34 N., R. 23 E., corner of secs. 4, 5, 32, and 33; stone	2,827.64
Tps. 33 and 34 N., R. 23 E., 1 foot east of corner of secs. 3, 4, 33, and 34; iron post stamped "2826 HAVRE"	2,832.061
Tps. 33 and 34 N., R. 23 E., corner of secs. 2, 3, 34, and 35; stone	2,833.57
Tps. 33 and 34 N., R. 23 E., corner of secs. 1, 2, 35, and 36; stone	2,864.60
Tps. 33 and 34 N., Rs. 23 and 24 E., 1 foot east of stone at corner of iron post stamped "2928 HAVRE"	2,934.094
Tps. 33 and 34 N., R. 24 E., corner of secs. 5, 6, 31, and 32; stone	2,883.19
Tps. 33 and 34 N., R. 24 E., corner of secs. 4, 5, 33, and 34; stone	2,949.13

[1] The first 3 miles are checked by return line.

	Feet.
Tps. 33 and 34 N., R. 24 E., 1 foot east of stone at corner of secs. 3, 4, 33, and 34; iron post stamped "2935 HAVRE"	2,941.084
T. 34 N., R. 24 E., corner of secs. 27, 28, 33, and 34; stone	3,014.23
T. 34 N., R. 24 E., corner of secs. 21, 22, 27, and 28; stone	3,183.25
T. 34 N., R. 24 E., 150 feet north of corner of secs. 15, 16, 21, and 22, at top of butte; iron post stamped "3226 HAVRE"	3,231.940
T. 34 N., R. 24 E., corner of secs. 9, 10, 15, and 16; stone	3,152.07
Tps. 34 and 35 N., R. 24 E., 255 feet west of corner of secs. 3, 4, 33, and 34; iron post stamped "3150 HAVRE"	3,155.863
Tps. 34 and 35 N., R. 24 E., witness corner to secs. 5, 6, 31, and 32; stone	3,136.29
Tps. 34 and 35 N., Rs. 23 and 24 E., 125 feet east of stone at corner of secs. 1, 6, 31, and 36, on slight ridge; iron post stamped "3191 HAVRE"	3,196.981
Tps. 34 and 35 N., R. 23 E., corner of secs. 1, 2, 35, and 36; stone	3,208.72
Tps. 34 and 35 N., R. 23 E., corner of secs. 2, 3, 34, and 35; stone	3,166.45
Tps. 34 and 35 N., 120 feet west of corner of secs. 3, 4, 33, and 34; iron post stamped "3209 HAVRE"	3,214.999
Tps. 34 and 35 N., R. 23 E., corner of secs. 4, 5, 32, and 33; stone	3,241.21
T. 34 N., R. 23 E., at northwest corner of; stone	3,287.34
Tps. 34 and 35 N., R. 23 E., corner of secs. 5, 6, 31, and 32; stone	3,290.47

Southwest corner of T. 33 N., R. 23 E., east along standard parallel to standard township corner, T. 33 N., Rs. 24 and 25 E.

T. 33 N., R. 23 E., standard corner of secs. 31 and 32; corner stone	2,592.15
T. 33 N., R. 23 E., standard corner of secs. 32 and 33; corner stone	2,589.93
T. 33 N., R. 23 E., 1 foot east of standard corner of secs. 33 and 34, at north edge of flat stone; iron post stamped "2598 HAVRE"	2,604.098
T. 33 N., R. 23 E., at standard corner of secs. 34 and 35; stone	2,602.96
T. 33 N., R. 23 E., at standard corner of secs. 35 and 36; stone	2,562.58
T. 33 N., R. 23 and 24 E., 80 feet west of standard stone corner of, at south point of ridge, west of east fork of Wayne Creek; iron post stamped "2563 HAVRE"	2,569.206
T. 33 N., R. 24 E., standard corner of secs. 31 and 32; stone	2,670.40
T. 33 N., R. 24 E., standard corner of secs. 32 and 33; stone	2,702.74
T. 32 N., R. 24 E., stone at closing corner of secs. 2 and 3, 1 foot east of; iron post stamped "2715 HAVRE"	2,721.121
T. 33 N., R. 24 E., south corner of secs. 34 and 35; stone	2,678.37
T. 33 N., R. 24 E., 200 feet west of creek, at south corner of secs. 35 and 36; stone	2,579.66
T. 33 N., Rs. 24 and 25 E., 1 foot east of standard corner stone; iron post stamped "2677 HAVRE"	2,683.305

Sec. 5, T. 37 N., R. 21 E., east along United States and Canada boundary line 5 miles, thence south to sec. 31, T. 35 N., R. 22 E.

T. 37 N., R. 21 E., about sec. 4, 1 mile west of Cherry Ridge Hills, on United States and Canada boundary line, 80 feet south of Canadian section corner, north edge of coulee; iron post stamped "3106"	3,111.823
T. 37 N., R. 21 E., about sec. 3, at foot of steep hill; point on iron pin (Canadian section corner) marked "3246"	3,251.91
T. 37 N., R. 21 E., about sec. 2 (unbounded), on United States and Canada boundary line, in small coulee; point on iron pin (Canadian section corner) marked "3342"	3,347.77
T. 37 N., R. 21 E., about sec. 1 (unbounded), on United States and Canada boundary line; southwest corner of monument, marked "3379"	3,385.01

	Feet.
T. 37 N., R. 21 E., about northeast corner of, on United States and Canada boundary line, in small valley, 70 feet south of Canadian section corner; iron post stamped "3327"	3,333.573
T. 37 N., R. 21 E., about center of east side of, on range line, 0.4 mile south of creek, 1 mile southeast of ranch, 0.8 mile west of second ranch, on prominent knoll; iron post stamped "3151"	3,157.303
T. 36 N., R. 22 E., near quarter corner of sec. 6 (probably), 1.2 miles northeast of ranch, marked by large pile of stone; iron post stamped "3304"	3,310.099
T. 36 N., R. 22 E., 300 feet west of quarter corner between secs. 18 and 19, 500 feet west of road, 0.7 mile southwest of ranch; iron post stamped "3419"	3,424.742
T. 35 N., R. 22 E., 300 feet south of quarter corner on north side of sec. 6, on north bank of deep coulee; iron post stamped "3315"	3,321.547
T. 35 N., R. 22 E., 600 feet south of quarter corner on north side of sec. 19; 1 mile north of creek, on prominent knoll; iron post stamped "3091"	3,096.852
T. 35 N., R. 22 E., 0.2 mile west of southeast corner of sec. 31, at top of ridge; iron post stamped "2955 HAVRE"	2,961.162

Section line between secs. 2 and 35, Tps. 34 and 35 N., R. 22 E., north to Canadian line, thence east along line to corner of secs. 1, 2, 35, and 36, Tps. 37 and 38 N., R. 24 E., thence southeast to Tps. 36 and 37 N., Rs. 24 and 25 E., thence south along range line to Tps. 34 and 35 N., Rs. 24 and 25 E., thence west along township line to corner of secs. 3, 4, 33, and 34, Tps. 34 and 35 N., R. 24 E.

Tps. 34 and 35 N., R. 22 E., 900 feet northeast of quarter corner between secs. 2 and 35, 500 feet north of township line, top of flat butte; iron post stamped "HAVRE 3299"	3,305.386
T. 35 N., R. 22 E., quarter corner on east side of sec. 25; stone	3,337.19
T. 35 N., R. 22 E., 300 feet north of southeast corner of sec. 24, on top of high round butte; iron post stamped "3383 HAVRE"	3,388.925
T. 35 N., R. 23 E., northwest corner of sec. 19, on range line; top of corner stone	3,328.67
T. 35 N., Rs. 22 and 23 E., on range line on west side of road leading from Snyder's ranch across range line to Murphy's Coulee, stone painted "3358"	3,363.93
T. 35 N., R. 23 E., northwest corner of sec. 7, in bottom of Murphy's Coulee; corner stone	3,312.42
T. 35 N., R. 22 E., 200 feet west of quarter corner on east side of sec. 1, north of Murphy's Coulee; iron post stamped "HAVRE 3347"	3,353.095
Tps. 35 and 36 N., Rs. 22 and 23 E., at township corner, on top of ridge; stone painted "3394"	3,400.48
T. 36 N., R. 23 E., northwest corner of sec. 31; corner stone painted "3333"	3,339.10
T. 36 N., R. 23 E., west quarter corner of sec. 30, near springs; post painted "3257"	3,262.74
T. 36 N., R. 22 E., SE. ¼ of sec. 24, 1,000 feet southwest of quarter corner of secs. 19 and 24, 500 feet northwest of lake bed, on top of terrace; iron post stamped "HAVRE 3288"	3,293.430
T. 36 N., R. 23 E., southwest corner of sec. 7 at top of divide between Woody Island Coulee and branch coulee; corner stone painted "3223"	3,228.98
T. 36 N., R. 23 E., quarter corner on west side of sec. 7, on top of divide, painted "3215"	3,220.72
T. 36 N., R. 23 E., southwest corner of sec. 6, north of Woody Island Coulee, south side of slope; corner stone painted "3225"	3,230.73
T. 36 N., Rs. 22 and 23 E., 9th standard paralled, 35 feet southeast of township corner, on top of divide; iron post stamped "HAVRE 3228"	3,233.563

	Feet.
T. 37 N., Rs. 22 and 23 E., 1.8 miles north of, on 9th standard parallel, on flat 100 feet east of a small round hill; stone painted "3189"	3,194.44
T. 37 N., Rs. 22 and 23 E., 3 miles north of township corner of, on 9th standard parallel, on divide between coulees, at top of small sand hill; iron post stamped "HAVRE 3190"	3,195.852
T. 37 N., R. 22 E., quarter corner on east side of sec. 12; stone painted "3143"	3,149.08
T. 37 N., R. 23 E., 0.5 mile northeast of quarter corner on west side of sec. 7, on top of ridge between two coulees; stone	3,111.47
T. 37 N., Rs. 22 and 23 E., township corner, on Canadian boundary line; iron post stamped "HAVRE 3162"	3,167.758
T. 37 N., R. 23 E., 1.6 miles east of northwest township corner, on Canadian boundary line at boundary post; stone painted "3007"	3,012.82
T. 37 N., R. 23 E., northeast corner of sec. 5, on Canadian boundary line; stone painted "2999"	3,005.36
T. 37 N., R. 23 E., northeast corner of sec. 4, on Canadian boundary line, bottom of large coulee; iron post stamped "HAVRE 3016"	3,021.625
T. 37 N., R. 23 E., northeast corner of sec. 3, on Canadian boundary line; stone painted "3085"	3,091.10
T. 37 N., R. 23 E., northeast corner of sec. 2, on Canadian boundary line; stone painted "3103"	3,108.60
T. 37 N., Rs. 23 and 24 E., township corner, on Canadian boundary line, 100 feet east of large hill, edge of dry lake; iron post stamped "HAVRE 3072"	3,076.864
T. 37 N., R. 24 E., 1 mile east of northwest township corner, on Canadian boundary line, 200 feet southeast of Canadian section corner; stone painted "3117"	3,121.28
T. 37 N., R. 24 E., 2 miles east of northwest township corner, on Canadian boundary line, 200 feet southeast of Canadian section corner; stone painted "3077"	3,081.73
T. 37 N., R. 24 E., 3 miles east of northwest township corner, on Canadian boundary line, 600 feet east of Canadian section corner, 500 feet east of dry lake, on small hill; iron post stamped "HAVRE 3045"	3,049.269
T. 37 N., R. 24 E., 4 miles east of northwest township corner, on Canadian boundary line, 800 feet southeast of Canadian section corner; stone painted "3030"	3,034.41
T. 37 N., R. 24 E., 5 miles east of northwest township corner, Canadian boundary line, 300 feet southeast of Canadian section corner; iron post stamped "HAVRE 3045"	3,049.623
T. 37 N., R. 24 E., on hill, 1 mile west of range line, 1 mile south of Canadian boundary line; stone painted "3027"	3,031.26
T. 37 N., R. 24 E., 0.8 mile west of range line, 2 miles south of Canadian boundary line, on ridge, 400 feet south of small lake; large stone painted "2987"	2,991.65
T. 37 N., R. 24 E., 0.5 mile west of range line, 3 miles south of Canadian boundary line, on top of hill; iron post stamped "HAVRE 2984"	2,988.091
T. 37 N., R. 24 E., 4 miles south of Canadian boundary line, bottom of large coulee, at northeast corner of fence; stone painted "2880"	2,884.09
T. 37 N., R. 25 E., 5 miles south of Canadian boundary line, south of large coulee, on bench at west edge of branch coulee; stone painted "2934"	2,938.98
T. 36 N., R. 25 E., northeast corner of sec. 6, on 9th standard parallel, on flat; stone painted "3064"	3,068.44
T. 36 N., Rs. 24 and 25 E., closing township corner, on 9th standard parallel, on flat; iron post stamped "HAVRE 3088"	3,092.805
T. 36 N., R. 24 E., southeast corner of sec. 1; stone painted "3071"	3,075.04

	Feet.
T. 36 N., R. 24 E., southeast corner of sec. 12; stone painted "3076"	3,080.32
T. 36 N., R. 24 E., southeast corner of sec. 13, 300 feet east of house, on flat; iron post stamped "HAVRE 3078"	3,082.502
T. 36 N., R. 24 E., southeast corner of sec. 24; stone painted "3069"	3,073.42
T. 36 N., R. 24 E., southeast corner of sec. 25; stone painted "3063"	3,067.93
Tps. 35 and 36 N., Rs. 24 and 25 E., township corner, on flat; iron post stamped "HAVRE 3067"	3,071.027
T. 35 N., R. 24 E., southeast corner of sec. 1; stone painted "3083"	3,087.61
T. 35 N., R. 24 E., stone at southeast corner of sec. 12; top of stone	3,106.25
T. 35 N., R. 24 E., southeast corner of sec. 13, on flat; iron post stamped "3109"	3,113.660
T. 35 N., R. 24 E., southeast corner of sec. 24; stone painted "3123"	3,127.65
T. 35 N., R. 24 E., southeast corner of sec. 25; stone painted "3107"	3,111.20
Tps. 34 and 35 N., Rs. 24 and 25 E., township corner; stone painted "3150"	3,154.45
T. 35 N., R. 24 E., 800 feet northwest of southeast corner of sec. 35, 800 feet south of house; stone painted "3155"	3,158.99
Tps. 34 and 35 N., R. 24 E., corner of secs. 34, 35, 2, and 3; stone painted "3144"	3,148.52
Tps. 34 and 35 N., R. 24 E., 255 feet west of corner of secs. 3, 4, 33, and 34; iron post stamped "3150 HAVRE"	3,155.863

DODSON QUADRANGLE.

Southeast corner of sec. 25, T. 32 N., R. 26 E., south to point 3.2 miles west of Dodson.

T. 32 N., Rs. 26 and 27 E., corner of secs. 25, 30, 31, and 36; stone	2,611.77
Tps. 31 and 32 N., Rs. 26 and 27 E., 1 foot east of stone at corner of; iron post stamped "2582 HAVRE"	2,588.863
T. 31 N., Rs. 26 and 27 E., corner of secs. 1, 6, 7, and 12; stone	2,523.028
T. 31 N., Rs. 26 and 27 E., corner of secs. 7, 12, 13, and 18; stone	2,474.41
T. 31 N., Rs. 26 and 27 E., 325 feet south of corner of secs. 13, 18, 19, and 24; iron post stamped "2501 HAVRE"	2,508.036
T. 31 N., Rs. 26 and 27 E., corner of secs. 19, 24, 25, and 30; stone	2,440.80
T. 31 N., Rs. 26 and 27 E., corner of secs. 25, 30, 31, and 36; nail on top of loose stake	2,291.06

Point near Savoy east along Great Northern Ry. to Wagner.

Savoy, 2.5 miles east of, 300 feet west of old road crossing, on south side of public road, in eighth post from fence corner; spike	2,335.70
Coburg, 1.5 miles west of, north of white and blue house, 50 feet east of signboard marked "518 2/10," south of railway embankment; circle on rock	2,322.05
Coburg, 0.5 mile west of, south side of public road, south of hand-car stand on railroad; spike in fence post	2,307.63
Coburg, at northwest corner of station; iron post stamped "2303 HAVRE"	2,309.816
Coburg, 1 mile east of, at road crossing; spike in signpost	2,307.41
Eureka, 3.1 miles east of, at water tank dam site, 100 feet south of right of way of Great Northern Ry., 100 feet north of Milk River; iron post stamped "2306"	2,313.296
Dodson, T. 31 N., R. 27 E., sec. 32, 200 feet east of section house, 75 feet north of railroad; iron post stamped "2287"	2,293.402
Dodson, 3.5 miles east of, at corner of fence near gate in front of Errickson's house, near Great Northern Ry.; iron post stamped "2288"	2,294.497
Wagner, opposite third telegraph pole west of station, 200 feet north of track; iron post	2,283.957

Coburg south to mouth of White Bear Creek, thence east along south side of Milk River to point near Malta.

	Feet.
Fort Belknap agency, 17 miles east of, station 2575, on spur of ridge at east side of mouth of White Bear Creek Valley, 150 feet south of road; iron post stamped "2340 HAVRE"	2,345.958
Fort Belknap agency, 20 miles east of, station 2802; iron post stamped "2332 HAVRE"	2,338.310
Dodson, 7.2 miles southwest of, 24 miles east of Fort Belknap, 1 mile west of Peoples Creek, on end of ridge 25 feet east of station 3015; iron post stamped "2333 HAVRE"	2,339.225
Dodson, 3.2 miles west of, at water tank dam site, on south side of river, edge of bank at ford by old water tank; iron post stamped "2281"	2,288.231

GILDFORD QUADRANGLE.

Burnham west along south side of T. 33 N.

T. 33 N., R. 13 E., southwest corner of sec. 31, 0.75 mile south of Kremlin siding; iron post stamped "2877 HAVRE"	2,882.994
T. 33 N., R. 12 E., southwest corner of sec. 34; iron post stamped "2950 HAVRE"	2,955.918
T. 33 N., R. 12 E., southwest corner of sec. 31; iron post stamped "2871 HAVRE"	2,877.037

Southwest corner of T. 33 N., R. 13 E., north to Milk River.

T. 33 N., R. 13 E., 180 feet north of northwest corner of sec. 19; iron post stamped "2722 HAVRE"	2,728.054
T. 33 N., R. 13 E., 16 feet north of northwest corner of sec. 6; iron post stamped "2684 HAVRE"	2,690.092
T. 34 N., R. 13 E., 20 feet north of northwest corner of sec. 19; iron post stamped "2684 HAVRE"	2,690.142

Southwest corner of T. 33 N., R. 12 E., north to Milk River.

T. 33 N., R. 12 E., southwest corner of sec. 18; iron post stamped "2861 HAVRE"	2,866.925
T. 34 N., R. 12 E., southwest corner of sec. 31, in draw running east and west; iron post stamped "2867 HAVRE"	2,872.846
T. 34 N., R. 12 E., southwest corner of sec. 18, 1,000 feet west of small reservoir; iron post stamped "2758 HAVRE"	2,763.900
T. 35 N., R. 12 E., southwest corner of sec. 31, north side of draw east and west; iron post stamped "2744 HAVRE"	2,749.909
T. 35 N., R. 12 E., southwest corner of sec. 18; iron post stamped "2734 HAVRE"	2,739.797
T. 36 N., R. 12 E., southwest corner of sec. 31; iron post stamped "2731 HAVRE"	2,736.818

Kremlin south along west side of R. 13 E. to sec. 18.

T. 32 N., R. 13 E., southwest corner of sec. 18; iron post stamped "2868 HAVRE"	2,873.985

Southwest corner of T. 33 N., R. 13 E., south to northwest corner of sec. 19, T. 32 N., R. 13 E.

Holden's ranchhouse, 0.4 mile south of, 500 feet east of northwest corner of sec. 19; iron post stamped "2753 HAVRE"	2,759.024

Point 3.5 miles west of Frenso northeast along section and quarter section line to Sprague ranch (portion of line).

	Feet.
Burnham, 7.5 miles west of, west end of Burnham base line, southwest of road crossing, on top of knoll; iron post stamped "2793 HAVRE".....	2,798.969
T. 33 N., R. 13 E., near southeast corner of sec. 10, Chain Lake triangulation station, on large knoll east of Chain Lake; iron post stamped "2731 HAVRE".....	2,737.394

John Brown's ranch up Milk River to international boundary line.

T. 34 N., R. 13 E., north of southeast corner of sec. 22; iron post stamped "2554 HAVRE".....	2,560.110
T. 34 N., R. 13 E., NW. ¼ sec. 17, 50 feet south of Tom Watson's ranch; iron post stamped "2566 HAVRE".....	2,572.002
T. 35 N., R. 12 E., south side of sec. 35, 80 feet south of Patrick Connolly's ranch, on north side of Milk River; iron post stamped "2577 HAVRE".	2,581.591
Connolly's ranch, 4 miles northwest of, 300 feet west of Percy Wilson's ranch, 100 feet east of river bank; iron post stamped "2591 HAVRE"..	2,595.571
Connolly's ranch, 7.5 miles northwest of, 1 mile north of spring coulee, 150 feet west of river bank, 75 feet north of cut bank on west bank of river, at south end of third bottom south of Simpson Bros.' ranch; iron post stamped "2591 HAVRE".....	2,595.644
Connolly's ranch, 12 miles northwest of, 15 feet west of road from Havre to Simpson Bros.' ranch, 0.2 mile southwest of ranch, 100 feet west of river on west bank; iron post stamped "2615 HAVRE".....	2,619.716
Connolly's ranch, 16 miles northwest of, at south end of third river bottom south of Johnson's ranch, 500 feet north of north point where river runs against second cut bank north of Simpson Bros.' ranch, 400 feet west of river bank; iron post stamped "2629 HAVRE".....	2,633.619
Connolly's ranch, 20 miles northwest of, 900 feet northeast of Peter Johnson's ranch, at mouth of coulee (road from Chester to Johnson's ranch runs through coulee 500 feet south of river bank); iron post stamped "2660 HAVRE".....	2,664.705

NOTE.—The remainder of this line is a single spur.

Kennedy's Coulee, 9.5 miles southeast of, 300 feet northeast of south end of third cut bank northwest of Johnson's ranch, southwest of small shanty on north bank of river, 0.5 mile northwest of large coulee which empties into river on north bank, 200 feet south of river bank; iron post stamped "2659 HAVRE".....	2,663.678
Kennedy's Coulee, 6.5 miles southeast of, 120 feet west of Alex Swain's house, 400 feet north of river bank, 0.5 mile southwest of monument on international boundary line; iron post stamped "2684 HAVRE".....	2,688.706
Kennedy's Coulee, 3 miles southeast of, 250 feet northwest of John B. Wasesha's ranch, at northwest corner of garden fence, 10 feet south of road in river valley; iron post stamped "2694 HAVRE".....	2,698.618
Kennedy's Coulee, near mouth of, 600 feet north of log cabin, 80 feet south of ditch on south side of river (Spencer's winter ranch is on north side of river on Canadian territory); iron post stamped "2713 HAVRE"....	2,717.614

HAYS QUADRANGLE.

Point near Montauk east along Great Northern Ry. to point 1.5 miles east of Savoy.

	Feet.
Wayne Creek, 0.5 mile east of, south right of way fence; iron post stamped "2341 HAVRE"	2,347.661
Savoy, 1.5 miles west of, first crossroads west of village, 50 feet south of south right of way fence; circle on rock	2,332.68
Savoy, 0.5 mile west of, directly south of trestle 524; circle on northeast corner of wagon bridge	2,323.44
Savoy, 0.5 mile east of, 200 feet west of trestle 520, beside rail driven in ground, 50 feet south of railroad; iron post stamped "2319 HAVRE"	2,325.961

Sec. 28, T. 32 N., R. 22 E., southeast along Chinook Canal line to White Bear Creek.

Fort Belknap agency, 0.75 mile southeast of, at station 1383, 600 feet north of stock yards; iron post stamped "2361 HAVRE"	2,367.026
Fort Belknap agency, 4 miles east of, at station 1635, on hillside, 500 feet south of main road; iron post stamped "2356 HAVRE"	2,362.070
Fort Belknap agency, 8 miles east of, at station 1860, on hillside, east side of 3 mile coulee; iron post stamped "2351 HAVRE"	2,357.230
Fort Belknap agency, 12 miles southeast of, 1,000 feet southwest of point where agency ditch strikes foothills, at station 2085; iron post stamped "2346 HAVRE"	2,352.259
Fort Belknap agency, 16 miles southeast of, 800 feet east of White Bear Creek, station 2322; iron post stamped "2342 HAVRE"	2,347.986

LONESOME LAKE QUADRANGLE.

Box Elder southwest along Great Northern Ry. to Missouri River Commission bench mark 17/2, near Virgelle.

Big Sandy, 0.2 mile south of station, 0.3 mile north of milepost 32, 100 feet west of railroad at north road crossing, in corner of fence; iron post	2,701.588
Verona, about 8 miles southwest of Big Sandy, on top of small knoll; iron post	2,716.935
Verona, 2 miles south of, 1,000 feet north of switch signal, on west side of track, 150 feet south of road crossing, 50 feet east of track; iron post	2,712.915
Cairo, 1 mile southeast of reservoir, 2 miles northwest of railroad, 10 feet south of fence; iron post	2,730.173
Cairo, 2.4 miles from reservoir, 1 mile west of railroad, 1,500 feet southwest of sheep shed, 250 feet southeast of station 492, 10 feet south of corner of fence; iron post	2,713.150
Virgelle, 0.5 mile below station, on left bank of river, 600 feet east of sheep shed, 0.2 mile from V. Blankenbaker's ranch; subsurface mark under iron post (Missouri River Commission bench mark 17/2)	2,534.132

Black Coulee east to Big Sandy (Marias subproject levels).

Lonesome Prairie, 10 miles west of Big Sandy, 0.5 mile west of "Twelve Mile" Coulee, 15 feet south of road from Big Sandy to Black Coulee; iron post	2,861.990

Virgelle west along Lower Marias preliminary canal route to southwest corner of T. 27 N., R. 10 E.

Tps. 26 and 27 N., R. 11 E., 10 feet north of quarter corner between secs. 33 and 4; iron post stamped "2805"	2,817.767
T. 26 N., R. 11 E., 10 feet west of quarter corner between secs. 5 and 6; iron post stamped "2835"	2,847.678

	Feet.
T. 26 N., R. 10 E., NE. ¼ NE. ¼ sec. 13, on south bank at large coulee, 800 feet south of quarter corner in north line of sec. 13; iron post stamped "2854"	2,866.699
T. 26 N., R. 10 E., SW. ¼ NE. ¼ sec. 16, top of small round hill in southeast slope at range between Missouri River and Marias River, 900 feet south of Fort Benton road, at point where it crosses ridge; iron post stamped "2980"	2,992.768

Southwest corner of sec. 18 T. 32 N., R. 13 E., south along west line of R. 13 E. to Big Sandy.

T. 32 N., R. 13 E., southwest corner of sec. 31; iron post stamped "2795 HAVRE"	2,800.877
T. 31 N., R. 13 E., southwest corner of sec. 18; iron post stamped "2728 HAVRE"	2,733.960
T. 31 N., R. 13 E., southwest corner of sec. 31; iron post stamped "2788 HAVRE"	2,793.972
T. 30 N., R. 13 E., southwest corner of sec. 18; iron post stamped "2752 HAVRE"	2,758.000
T. 30 N., R. 13 E., southwest corner of sec. 31; iron post stamped "2791 HAVRE"	2,796.870
T. 29 N., R. 13 E., southwest corner of sec. 18; iron post stamped "2704 HAVRE"	2,709.927
T. 28 N., R. 13 E., northwest corner of sec. 6; iron post stamped "2872 HAVRE"	2,877.894

Southwest corner of T. 32 N., R. 13 E., east to sec. 34.

T. 32 N., R. 13 E., southwest corner of sec. 34; iron post stamped "2837 HAVRE"	2,842.964

Northwest corner of sec. 19 south along west side of R. 12 E. and east along south side of T. 29 N., R. 12 E.

T. 32 N., R. 12 E., southwest corner of sec. 31; iron post stamped "2876 HAVRE"	2,881.979
T. 31 N., R. 12 E., southwest corner of sec. 18; iron post stamped "2844 HAVRE"	2,850.050
T. 31 N., R. 12 E., southwest corner of sec. 31; iron post stamped "2844 HAVRE"	2,850.043
T. 30 N., R. 12 E., southwest corner of sec. 18; iron post stamped "2852 HAVRE"	2,858.016
T. 30 N., R. 12 E., southwest corner of NW. ¼ sec. 31; iron post stamped "2852 HAVRE"	2,857.982
T. 29 N., R. 12 E., southwest corner of N.W ¼ sec. 18, west end of lake bed of Lonesome Lake, east end of fence of Armentrout's ranch; iron post stamped "2753 HAVRE"	2,758.905
T. 29 N., R. 12 E., southwest corner of NW. ¼ sec. 31; iron post stamped "2851 HAVRE"	2,857.028
T. 29 N., R. 12 E., southwest corner of SE. ¼ sec. 33; 150 feet northeast of wagon road from Ihmsen's ranch to Big Sandy; iron post stamped "2851 HAVRE"	2,856.961
T. 28 N., R. 13 E., northwest corner of sec. 6, 3 miles north of Big Sandy; iron post stamped "2872 HAVRE"	2,877.894

Northwest corner T. 28 N., R. 13 E., south along west side of R. 13 E. and along section lines in R. 13 E. to Missouri River Commission bench mark 17/2.

	Feet.
T. 28 N., R. 12 E., southwest corner of sec. 18; iron post stamped "2913 HAVRE"	2,918.886
T. 28 N., R. 12 E., southwest corner of sec. 31; iron post stamped "3003 HAVRE"	3,008.962
T. 27 N., R. 12 E., southeast corner of sec. 7; iron post stamped "2744 HAVRE"	2,746.546
Verona, in front of rail rest; top of spike (Great Northern Railway bench mark)	2,723.6
T. 27 N., R. 12 E., southeast corner of sec. 20; iron post stamped "2657 HAVRE"	2,662.762

Along south and west sides of T. 28 N., R. 11 E., to Lonesome Prairie Marias canal bench mark in T. 29 N., R. 11 E.

T. 28 N., R. 11 E., southwest corner of sec. 34; iron post stamped "3031 HAVRE"	3,036.973
T. 28 N., R. 11 E., southwest corner of sec. 31; iron post stamped "2987 HAVRE"	2,992.432
T. 28 N., R. 11 E., northwest corner of sec. 19; iron post stamped "2917 HAVRE"	2,922.683
T. 28 N., R. 11 E., northwest corner of sec. 6; iron post stamped "2859 HAVRE"	2,864.451

Around Tps. 29 and 30 N., R. 10 E., via east, north, and west sides to Marias canal and to southwest corner T. 29 N., R. 10 E.

T. 29 N., R. 11 E., northwest corner of sec. 19; iron post stamped "2848 HAVRE"	2,853.567
T. 29 N., R. 11 E., northwest corner of sec. 6; iron post stamped "2867 HAVRE"	2,873.376
T. 30 N., R. 10 E., northeast corner of sec. 24; iron post stamped "2896 HAVRE"	2,901.853
T. 30 N., R. 10 E., northeast corner of sec. 1; iron post stamped "2956 HAVRE"	2,961.919
T. 30 N., R. 10 E., northwest corner of sec. 3; iron post stamped "2957 HAVRE"	2,963.229
T. 30 N., R. 10 E., 700 feet west of northwest corner of sec. 6; iron post stamped "3011 HAVRE"	3,017.115
T. 30 N., R. 10 E., southwest corner of sec. 18; iron post stamped "2957 HAVRE"	2,963.316
T. 30 N., R. 10 E., southwest corner of sec. 31; iron post stamped "2864 HAVRE"	2,870.588
T. 29 N., R. 10 E., southwest corner of sec. 18; iron post stamped "2880 HAVRE"	2,886.074

Southwest corner of sec. 31, T. 27 N., R. 10 E., east to Lippards.

T. 27 N. R. 10 E., southeast corner of sec. 33; iron post stamped "2989 HAVRE"	2,994.663
T. 26 N., R. 10 E., southwest corner of sec. 15; iron post stamped "2990 HAVRE"	2,995.980
Lippards, on Great Northern Railway, 400 feet north of Missouri River; Missouri River Commission bench mark 11/2 (reading taken from inside of post at bottom)	2,561.053
Top of cap of iron post	2,565.134

Lonesome Lake circuit west in T. 29 N., R. 11 E., near contour 2780.

	Feet.
T. 29 N., R. 11 E., 1.8 miles west of Lonesome Lake, west end of circuit, south side of drain; iron post stamped "2774 HAVRE"	2,779.940
T. 29 N., R. 11 E., 3 miles west of Lonesome Lake, on north side of drain; iron post stamped "2773 HAVRE"	2,779.190

Around Lonesome Lake east and north in T. 27 N., R. 12 E.

T. 29 N., R. 12 E., 0.5 mile southwest of Johnsons; iron post stamped "2782 HAVRE"	2,788.100
Lonesome Lake, 1.5 miles east of northeast corner of, on hill sloping south; iron post stamped "2779 HAVRE"	2,785.100

West line of R. 10 E. east to sec. 7, T. 29 N., R. 10 E. (single spur line).

Black Coulee divide, T. 29 N., R. 10 E., sec. 7, 367 feet south, 13° 27′ west of northeast corner, east side of divide, on knoll; iron post stamped "2890"	2,895.036

SOOSE MOUNTAINS QUADRANGLE.

Northwest corner of T. 26 N., R. 10 E., west and north along Lower Marias preliminary canal route to point east of Black Coulee in T. 29 N.

Tps. 26 and 27 N., Rs. 9 and 10 E., corner of; iron post stamped "2963"	2,976.250
T. 26 N., R. 9 E., SW. ¼ NW. ¼ sec. 11, end of preliminary canal line, station 2059; iron post stamped "2970"	2,983.498
T. 26 N., Rs. 8 and 9 E., secs. 1, 12, 6, and 7, 5 feet west of corner stone; iron post stamped "2967"	2,979.765
T. 27 N., R. 8 E., 4.5 feet west of northeast corner of sec. 25; iron post stamped "3053"	3,066.030
T. 27 N., R. 9 E., 280 feet east of southwest corner of sec. 6; iron post stamped "3035"	3,047.838
T. 27 N., R. 9 E., 120 feet south of town line, 0.2 mile east of northwest corner of sec. 5; iron post stamped "3106"	3,119.176
T. 28 N., R. 9 E., 5 feet east of northwest corner of sec. 28; iron post stamped "2991"	3,004.218
T. 28 N., R. 9 E., 5 feet west of southwest corner of sec. 10; iron post stamped "2965"	2,977.902
T. 28 N., R. 9 E., 5 feet west of northwest corner of sec. 2; iron post stamped "2945"	2,961.129
T. 29 N., R. 9 E., southwest corner of sec. 22, is S. 26° 30′ W., 1,626 feet from post which is 30 feet northwest of corner of Godfrey's fence, 35 feet from east edge of Black Coulee; iron post stamped "2884"	2,899.536

Southwest corner of T. 29 N., R. 10 E., south 12 miles along west side of R. 10 E.

T. 28 N., R. 10 E., southwest corner of sec. 18; iron post stamped "2918 HAVRE"	2,924.406
T. 28 N., R. 10 E., southwest corner of sec. 31; iron post stamped "2956 HAVRE"	2,962.139
T. 27 N., R. 10 E., southwest corner of sec. 18; iron post stamped "3077 HAVRE"	3,082.966
T. 27 N., R. 10 E., southwest corner of sec. 31; iron post stamped "2970 HAVRE"	2,976.250

Sec. 11, T. 29 N., R. 5 E., east along Marias canal route to west line of R. 10 E.[1]

	Feet.
T. 29 N., R. 6 E., 2 feet west of southeast corner of sec. 16, 0.5 mile northeast of J. C. Quaig's house; iron post	2,787.143
T. 29 N., R. 7 E., southeast of center of sec. 17, 0.5 mile north of James Townsend's house, at fork of road, below Cottonwood or Sweetgrass Creek; iron post	2,743.226
Forger's ranch house, 1,000 feet southeast of, at big bend in Marias River, 100 feet southeast of small reservoir, 8 feet north of road, 160 feet north of river, on opposite side of river from goblet-shaped rock, about 800 feet to northwest; iron post	2,697.260

Sec 17, T. 29 N. R. 7 E., northeast to west line of R. 10 E.[2]

H. Brinkman's place, ford above, on south side of river, southeast of road; nail in cottonwood	2,739.292
Ranch house formerly owned by C. Brinkman, 400 feet northeast of; nail in root of cottonwood tree 2.5 feet in diameter	2,706.257
Marias dam site, west end of, on east slope of hill; iron post stamped "2896"	2,909.520
Forger's ranch, 0.5 mile above, south side of road, on south side of river; iron post stamped "2684." (This bench mark is thought to be same as one in previous line, though descriptions seem to conflict.)	2,697.260
T. 29 N., R. 8 E., 0.5 mile above Forger's ranch, on north side of river, on hill, corner between secs. 16 and 17; iron post stamped "2887"	2,900.488
Marias River, 0.5 mile north of, 0.8 mile northwest of Thorn's ranch; iron post stamped "2878"	2,891.286
Dutch Henry's ranch, 0.5 mile north of, north side of Marias River, on bluff; iron post stamped "2897"	2,910.302
Black Coulee, west side of, 2,000 feet northwest of cabin, 2 miles from Godfrey's ranch; iron post stamped "2862"	2,876.018
T. 29 N., R. 9 E., 390 feet south, 42° 10′ east of northwest corner of sec. 11; iron post stamped "2856"	2,870.295

THIBEDEAU LAKE QUADRANGLE.

Havre west along Great Northern Ry. to Fresno.

Havre, 0.4 mile east of passenger station, southeast corner of foundation of Great Northern Railway water tank; bronze tablet stamped "2483 HAVRE"	2,488.650
Havre, northwest corner of grounds of United States Weather Bureau; iron post stamped "2487 HAVRE"	2,493.024
Havre, 1 mile west of, 40 feet north of road crossing; railroad spike in east end of culvert	2,484.89
Havre, 3.2 miles west of, at road crossing, 65 feet south of railroad track, west side of wagon road, near wire fence; iron post stamped "2495 HAVRE"	2,501.006
Pacific Junction, south side of track; nail in switch block	2,525.3
Pacific Junction, 2 miles west of, 270 feet east of Big Sandy Creek, 40 feet north of milepost 967, north side of track, by wire fence; iron post stamped "2500 HAVRE"	2,506.043
Burnham, 1 mile east of, 2,000 feet east of first road crossing east of Burnham, north of milepost 970, on edge of railroad right of way fence; iron post stamped "2610 HAVRE"	2,616.086

[1] These elevations can not be depended upon until supported by further field work, on account of a 2-foot error arbitrarily localized in this line.

[2] On account of a 2-foot error arbitrarily localized at the end of this line, these elevations can not be depended upon until supported by further field work. A central portion of this line was releveled.

	Feet.
Burnham, 1 mile west of, east end of base line at Burnham, 20 feet north of south fence of railroad right of way; iron post stamped "2645 HAVRE".	2,651.265
Fresno, T. 32 N., R. 14 E., near northwest corner of sec. 6 (unbounded), north side of railroad track, northwest corner of right-of-way fence, at road crossing; iron post stamped "2671 HAVRE"	2,677.042

Havre east along Great Northern Ry. to Toledo.

Havre, 1 mile east of, bridge 587; bolt in west end of north guard rail	2,487.72
Havre, 3 miles east of, 100 feet south of track, 250 feet southeast of milepost 427, south side of wagon road, beside wire fence; iron post stamped "2470 HAVRE"	2,475.974
Toledo, west end of switch at road crossing, 120 feet north of track, beside wire fence; iron post stamped "2459 HAVRE"	2,465.014

Havre north along road and east boundary of R. 15 E., thence southeast along Yantic road to sec. 5, T. 33 N., R. 17 E.

T. 33 N., R. 15 E., southeast corner of sec. 25, at fence corner; iron post stamped "2745 HAVRE"	2,750.905
Havre, 6 miles north of, 80 feet north of gate; iron post stamped "2882 HAVRE"	2,888.128
Havre, 8 miles north of, southwest corner of T. 34 N., R. 16 E., iron post stamped "2767 HAVRE"	2,772.927
Havre, 11 miles north of, T. 34 N., R. 16 E., southeast corner of sec. 13, T. 34 N., R. 16 E., 450 feet north of Yantic road; iron post stamped "2727 HAVRE"	2,733.216
Havre, 11 miles north of, south quarter corner on north side of sec. 28, T. 34 N., R. 16 E., northwest side of crossroads; iron post stamped "2681 HAVRE"	2,686.979
Yantic, 9.5 miles northwest of, near center of sec. 36, T. 34 N., R. 16 E., on slight ridge, 6 feet south of road; iron post stamped "2589 HAVRE"	2,595.016
T. 33 N., R. 17 E., NE. ¼ sec. 5, 12 feet north of road; iron post stamped "2558 HAVRE"	2,563.693

Pacific Junction southwest along Great Northern Ry. to Assiniboine.

Assiniboine, 35 feet south of station, 13 feet east of track, near telegraph pole; iron post stamped "2586 HAVRE"	2,591.972

Southwest corner of sec. 18, T. 34 N., R. 16 E., north along range line, thence east along north boundary of T. 34 N., to sec. 3, R. 17 E., T. 34 N.

T. 34 N., R. 16 E., 1,300 feet south of northwest corner, at top of ridge; iron post stamped "2713 HAVRE"	2,719.061
Tps. 34 and 35 N., R. 16 E., 340 feet west of quarter corner, between secs. 3 and3 4; iron post stamped "2653 HAVRE"	2,659.016
Tps. 34 and 35 N., R. 17 E., 330 feet east of quarter corner, between secs. 6 and 31; iron post stamped "2723 HAVRE"	2,729.051
Tps. 34 and 35 N., R. 17 E., 380 feet west of the corner of, secs. 3, 4, 33, and 34, at top of ridge; iron post stamped "2717 HAVRE"	2,722.989

Havre south along public road 3 miles, thence west to Assiniboine.

T. 32 N., R. 16 E., SW. ¼ sec. 20, at northwest corner of intersection of roads; iron post stamped "2735 HAVRE"	2,741.113
T. 32 N., R. 15 E., SW. ¼ sec. 24, 0.5 mile north of Ryan's sheep sheds, in southeast corner of crossroads; iron post stamped "2654 HAVRE"	2,658.543

Point south of Havre southeast along south side of Saddle Mountain to sec. 25, T. 32 N., R. 16 E.

	Feet.
Havre, 4 miles southeast of, 10 feet east of road running into Stocklan's ranch, 20 feet south of log cabin, at foot of hill, on north side of fence; iron post stamped "2576 HAVRE"	2,581.987
Havre, 5 miles southeast of, north part of sec. 25, T. 32 N., R. 16 E., at forks of roads; iron post stamped "2867 HAVRE"	2,873.128

Point 3.5 miles west of Fresno northeast to Sprague's ranch (portion of line).

T. 33 N., R. 13 E., 400 feet south of quarter corner on north side of sec. 23; 20 feet north of road; iron post stamped "2677 HAVRE"	2,683.027
T. 33 N., R. 13 E., near northeast corner of sec. 13, 17 miles northwest of Havre, 60 feet west of D. D. Sprague's ranch, on Milk River; iron post stamped "2528 HAVRE"	2,534.069

Sprague's ranch north along east line of R. 13 E. to sec. 12, T. 34 N., R. 13 E., thence east 6 miles, south 5 miles, and east to southeast corner of T. 34 N., R. 15 E.

T. 33 N., R. 13 E., sec. 1, 50 feet south of John Brown's ranch house; iron post stamped "2536 HAVRE"	2,542.067
T. 34 N., R. 13 E., 900 feet southwest of southeast corner of NW. ¼ sec. 25, on prominent knoll; iron post stamped "2703 HAVRE"	2,709.127
T. 34 N., R. 13 E., 130 feet northwest of quarter corner on east side of sec. 12, on prominent knoll; iron post stamped "2830 HAVRE"	2,836.088
T. 34 N., R. 14 E., 50 feet northeast of southeast corner of sec. 9; iron post stamped "2895 HAVRE"	2,901.077
T. 34 N., R. 14 E., 120 feet northwest of southeast corner of sec. 12; iron post stamped "2828 HAVRE"	2,834.156
Red Rock triangulation station, T. 34 N., R. 14 E., 273 feet east of quarter corner south side of sec. 25, on a prominent knoll, on divide between Milk River and Red Rock Coulee, 5 miles north of Milk River and 0.6 mile south of Havre Road; iron post stamped "2945 HAVRE"	2,951.095
T. 33 N., R. 14 E., 500 feet northeast of southeast corner of sec. 1, at bottom of coulee; iron post stamped "2801 HAVRE"	2,807.203
T. 33 N., R. 15 E., 30 feet east of southwest corner of sec. 3, about 500 feet north of east and west ridge, in red granite bowlder 18 by 24 by 6 inches above surface; bronze tablet stamped "2858 HAVRE"	2,863.770

Sec. 25, T. 34 N., R. 13 E., north along range line to northwest corner of sec. 1, T. 37 N., R. 13 E., thence east along boundary line between United States and Canada to northwest corner of sec. 1, T. 37, R. 15 E., thence south to point between secs. 31 and 6, Tps. 34 and 35 N., R. 16 E.

T. 24 N., R. 13 E., 900 feet southwest of southeast corner of NW. ¼ sec. 25, on prominent knoll; iron post stamped "2703 HAVRE"	2,709.127
T. 34 N., R. 13 E., 130 feet north west of southeast corner of sec. 12, on prominent knoll; iron post stamped "2830 HAVRE	2,836.55
T. 35 N., R. 13 E., 1,500 feet west of northwest corner of sec. 25, 0.4 mile east of gate, 0.5 mile southeast of lake, 600 feet north of fork of road, on prominent knoll; iron post stamped "2849"	2,854.507
T. 35 N., Rs. 13 and 14 E., corner of secs. 7, 18, 12, and 13; iron post stamped "2917"	2,922.677
T. 36 N., R. 13 E., in sec. 25, 1.2 miles south of fence corner, at reservoir, on prominent knoll; iron post stamped "2993"	2,998.879

	Feet.
T. 36 N., R. 13 E., in sec. 13, 1,500 feet north of dry lake on range line, on prominent knoll; iron post stamped "3038"	3,044.759
T. 37 N., R. 13 E., 900 feet northeast of southwest corner of sec. 25, near old dry lake bed; iron post stamped "2793"	2,798.511
T. 37 N., R. 13 E., 600 feet south of northwest corner of sec. 13, 1 mile southeast of Phifer's ranch, on old road; iron post stamped "2798"	2,803.920
T. 37 N., Rs. 13 and 14 E., 3 feet south of corner, on United States and Canada boundary line; iron post stamped "2821"	2,827.326
T. 37 N., R. 14 E., in sec. 4, 1 mile east of monument on United States and Canada boundary line, 700 feet north of coulee running northwest-southeast, on top of hill; iron post stamped "2835"	2,840.847
T. 37 N., R. 14 E., about northeast corner of sec. 1, 1 mile east of monument on United States and Canada boundary line, 0.4 mile east of and 0.2 mile north of coulee; iron post stamped "2849"	2,855.106
T. 37 N., R. 15 E., about NE. ¼ sec. 5, monument on United States and Canada boundary line; stake in ground marked "2807"	2,812.87
T. 37 N., R. 15 E., about NW. ¼ sec. 3, 0.4 mile east of monument, 0.8 mile east of road, on Uuited States and Canada boundary line; iron post stamped "2781"	2,786.9[illegible]
T. 37 N., R. 15 E., about NE. ¼ sec. 2, at corner of fence by monument on United States and Canada line, 600 feet west of West Fork Creek; Canadian bench mark, concrete plate with iron bolt in center, marked "2738 C"	2,757.939
T. 37 N., R. 15 E., in vicinity of sec. 2, 1 mile south of United States and Canada boundary line, 0.8 mile west of West Fork Creek, 600 feet south of small coulee; iron post stamped "2745"	2,751.334
T. 37 N., R. 15 E., in vicinity of southwest corner of sec. 13, 3 miles south of United States and Canada boundary line, 1 mile north of Creedmans Coullee, on top of hill; point on rock marked "2744"; location marked by big pile of rock	2,750.33
T. 37 N., R. 15 E., about northwest corner of sec. 25, 4 miles south of Canadian line, north bank of Creedmans Coulee, 1.3 miles southeast of house, and 1 mile west of second house, 0.3 mile north by 0.3 mile and west of wire fence; iron post stamped "2725"	2,733.378
T. 36 N., R. 15 E., in vicinity of southwest corner of sec. 1, 7 miles south of United States and Canada boundary line, at top of long hill, 3 miles south of big coulee; iron post stamped "2889"	2,894.849
T. 36 N., R. 15 E., in vicinity of south side of sec. 24, 10 miles south of United States and Canada boundary line, on east side of coulee, 1,000 feet west of dry lake bed, on prominent knoll; iron post stamped "2763''	2,768.621
T. 35 N., R. 16 E., 0.2 mile northeast of southwest corner of sec. 6, top of hill; iron post stamped "2785"	2,790.745
T. 35 N., R. 16 E., 700 feet north of quarter corner of secs. 19 and 26; iron post stamped "2715"	2,721.217
Havre, 13.8 miles north of, 1,300 feet south of corner of T. 35 N., R. 16 E., at top of ridge; iron post stamped "2713 HAVRE"	2,719.061

Sec. 2, T. 37 N., R. 15 E., east along United States and Canada boundary line to northwest corner of sec. 4, R. 17 E.

T. 37 N., R. 15 E., about sec. 1 (unbounded), 600 feet east of creek, 10 feet north of coulee, 30 feet south of United States and Canada boundary line, top of hill; point on top of iron pin marked "2763"	2,769.19
T. 37 N., R. 16 E., about sec. 6 (unbounded), 1 mile east of West Fork Creek, on United States and Canada boundary line, beside loose pile of rocks; iron post stamped "2783"	2,789.213

	Feet.
T. 37 N., R. 16 E., about NE. ¼ sec. 5, 600 feet east of coulee, 20 feet south of monument; point on top of large rock marked "2785"	2,790.61
T. 37 N., R. 16 E., about northeast corner of sec. 4 (unbounded), at top of big hill, 4.4 miles east of West Fork Creek, on United States and Canada boundary line, 0.5 feet south of monument; iron post stamped "2812"	2,817.581
T. 37 N., R. 17 E., northwest corner of sec. 6, 6 feet south of United States and Canada boundary line, 0.4 mile east of coulee, 0.5 mile west of Wood Pile Coulee, 100 feet north of old road; iron post stamped "2824"	2,829.684
T. 37 N., R. 17 E., 0.2 mile east of quarter corner of sec. 6, 0.3 mile east of Wood Pile Coulee, top of hill, at fence corner, 4 feet north of road; point on stone marked "2849"	2,854.83
T. 37 N., R. 17 E., corner of secs. 5 and 6; point on stone marked "2861"	2,867.29
T. 37 N., R. 17 E., corner of secs. 4 and 5, on United States and Canada boundary line; point on corner stone marked "2880"	2,885.998

ZURICH 30′ QUADRANGLE.

Toledo east along Great Northern Ry. to Zurich.

Yantic, 2.8 miles west of, at private road crossing, 65 feet south of track, west side of wagon road, by wire fence; iron post stamped "2458 HAVRE"	2,463.944
Yantic, in front of station; top of rail	2,449.2
Yantic, 600 feet east of station, 50 feet north of track, south side of wagon road at crossing, beside telegraph pole; iron post stamped "2440 HAVRE"	2,446,086
Chinook, 3.8 miles west of, north side of wagon road, 2 feet west of gate entrance to Empire ranch; iron post stamped "2417 HAVRE"	2,423.007
Chinook, northwest corner of Montana Hotel; iron post stamped "2422 HAVRE"	2,428.037
Chinook, 3 miles east of, 90 feet east of milepost 406, 40 feet east of irrigation ditch, south side of road, beside wire fence; iron post stamped "2394 HAVRE"	2,400.464
North Fork, east end of siding, 200 feet northeast of milepost 403, north side of wagon road, by fence corner; iron post stamped "2388 HAVRE"	2,394.362
Zurich, 150 feet west of switch stand, 150 feet north of railroad, north side of public road; iron post stamped "2382 HAVRE"	2,388.555

Sec. 5, T. 33 N., R. 17 E., east along north boundary of T. 33 N. and south to Chinook.

Tps. 33 and 34 N., R. 17 E., corner of secs. 1, 2, 35, and 36; iron post stamped "2594 HAVRE"	2,600.092
T. 33 N., R. 18 E., northwest corner of sec. 5; iron post stamped "2622 HAVRE"	2,627.996
T. 34 N., R. 18 E., northwest corner of sec. 36; iron post stamped "2721 HAVRE"	2,727.051
Chinook, 3 miles northwest of, 150 feet east of southwest corner of sec. 8, T. 33 N., R. 19 E.; iron post stamped "2476 HAVRE"	2,482.093

Northeast corner of sec. 4, T. 34 N., R. 17 E., east along township line to northwest corner of T. 35 N., R. 21 E.

Tps. 34 and 35 N., R. 18 E., quarter corner of secs. 6 and 31; iron post stamped "2664 HAVRE"	2,670.113
Tps. 34 and 35 N., R. 18 E., 800 feet east of corner of secs. 3, 4, 33, and 34, on east bank of West Fork Creek, on line; iron post stamped "2606 HAVRE"	2,612.034
T. 35 N., R. 18 E., southeast corner of; iron post stamped "2554 HAVRE"	2,560.016

	Feet.
Tps. 34 and 35 N., R. 19 E., 950 feet east of quarter corner of secs. 3 and 34, on line; iron post stamped "2656 HAVRE"	2,662.141
Tps. 34 and 35 N., R. 20 E., quarter corner of secs. 6 and 31; iron post stamped "2789 HAVRE"	2,795.184
Tps. 34 and 35 N., R. 20 E., at quarter corner of secs. 3 and 34, 8 feet east of Gibb's road; iron post stamped "2838 HAVRE"	2,844.190
T. 35 N., R. 21 E., 1,300 feet east of northwest corner, at top of ridge, on line; iron post stamped "2781 HAVRE"	2,787.228

Point 1.5 miles south of Bice coal mine east and north to Toledo.

T. 32 N., R. 17 E., 170 feet northeast of southeast corner of sec. 24, on top of prominent knoll; iron post stamped "2912 HAVRE"	2,918.157
T. 32 N., R. 18 E., 150 feet west of southeast corner of sec. 21, section corner marked with mound of rock; iron post stamped "2802 HAVRE"	2,807.097
T. 32 N., R. 18 E., 300 feet south of northeast corner of sec. 25; iron post stamped "2769 HAVRE"	2,775.251
T. 32 N., R. 19 E., quarter mile south of center of sec. 21, 600 feet west of county road running south from Chinook to Rhoeder's coal mine; iron post stamped "2727 HAVRE"	2,733.300

Toledo south, east, and north to Chinook.

Chinook, 3 miles south of, near northeast corner of sec. 15, T. 32 N., R. 19 E., 15 feet east of road, on prominent knoll; iron post stamped "2605 HAVRE"	2,611.380

Southwest corner of T. 34 N., R. 19 E., east along township line to southeast corner of T. 34 N., R. 20 E.

T. 34 N., R. 19 E., 40 feet east of southeast corner of sec. 33, on south side of fence line; iron post stamped "2494 HAVRE"	2,499.969
T. 34 N., R. 19 E., 0.2 mile south of sec. 36, North Fork triangulation signal; iron post stamped "2693 HAVRE"	2,699.394
T. 34 N., R. 20 E., 100 feet northeast of southeast corner of sec. 33; iron post stamped "2654 HAVRE"	2,660.060
T. 34 N., R. 20 E., 350 feet west of southeast corner of sec. 36, on rise of ground; iron post stamped "2675 HAVRE"	2,681.095

Southeast corner of sec. 22, T. 32 N., R. 21 E., west to point 5.5 miles south of Chinook.

T. 32 N., R. 21 E., southeast corner of sec. 19, 0.2 mile east of telephone line from Chinook to Herschburg, on A. Winters's sheep ranch; iron post stamped "2594 HAVRE"	2,600.366
T. 32 N., R. 20 E., 250 feet northeast of southeast corner of sec. 21, at top of prominent knoll; iron post stamped "2677 HAVRE"	2,683.290
T. 32 N., R. 19 E., southeast corner of sec. 24, 0.2 mile east of road from Chinook to Kerr's coal mine; iron post stamped "2752 HAVRE"	2,758.322

Chinook southeast along proposed Chinook canal to sec. 8, T. 32 N., R. 21 E.

Chinook, 3 miles southeast of, head of proposed Chinook canal, at south end of Winters-Anderson dam on south bank of Milk River; iron post stamped "2398 HAVRE"	2,403.930
Chinook, 6 miles southeast of, sec. 10, T. 32 N., R. 20 E., station 240, 3 feet north of road; iron post stamped "2384 HAVRE"	2,390.021
T. 32 N., R. 21 E., sec. 8, 1,000 feet north of hill road running to agency, on hillside at station 453; iron post stamped "2379 HAVRE"	2,385.165

Northwest corner of sec. 4, T. 37 N., R. 17 E., east along United States and Canada boundary line to sec. 2, T. 37 N., R. 19 E.

	Feet.
T. 37 N., R. 17 E., 6 feet south of corner of secs. 3 and 4, on United States and Canada boundary line, 1,000 feet east of monument; iron post stamped "2876"	2,881.405
T. 37 N., R. 17 E., corner of secs. 2 and 3, on United States and Canada boundary line; point on corner stone marked "2866"	2,870.86
T. 37 N., R. 17 E., north quarter corner of sec. 2, at top of hill, 10 feet south of monument; point on stone marked "2882"	2,887.47
T. 37 N., R. 17 E., corner of secs. 1 and 2, on United States and Canada boundary line, 10 feet west of monument; point on corner stone marked "2860"	2,864.27
T. 37 N., Rs. 17 and 18 E., north corner of, 1,500 feet west of North Fork Creek, 40 feet south of corner stone, 700 feet west of monument; iron post stamped "2803"	2,806.924
T. 37 N., R. 18 E., 2.1 miles east of northwest corner, 100 feet south of coulee, 0.5 mile east of monument, at Canadian section corner; top of iron pin marked "2858"	2,862.14
T. 37 N., R. 18 E., 3 miles east of northwest corner, 1,300 feet east of monument, 600 feet west of Canadian section corner, 40 feet north of road, 30 feet south of Canadian line, near lake bed; iron post stamped "2885"	2,888.802
T. 37 N., R. 18 E., about 0.6 mile west of northeast corner, top of hill, 1,500 feet north of reservoir, on United States and Canada boundary line 10 feet south of monument; iron post stamped "2894"	2,898.201
T. 37 N., R. 19 E., about 0.5 mile east of northwest corner, top of hill, on United States and Canada boundary line, 10 feet south of monument, at triangulation signal; iron post stamped "2909"	2,913.312
T. 37 N., R. 19 E., about 2 miles east of northwest corner, 100 feet east of Canadian section corner, on top of hill; point on rock marked "2898;" location marked by pile of rock	2,902.11
T. 37 N., R. 19 E., about sec. 13, 0.6 mile east of East Fork Creek, at top of hill, on United States and Canada boundary line, near fence corner; iron post stamped "2844"	2,850.529
T. 37 N., R. 19 E., about sec. 33, at top of hill, on United States and Canada boundary line, triangulation signal; iron post stamped "2859"	2,864.659
T. 37 N., R. 19 E., about sec. 2, on United States and Canada boundary line, 600 feet east of monument; iron post stamped "2844"	2,849.810

Northwest corner of sec. 1, T. 37 N., R. 17 E., south to quarter corner between secs. 6 and 31, Tps. 34 and 35 N., R. 18 E.

T. 37 N., R. 17 E., corner of secs. 1, 2, 11, and 12; point on section stone marked "2771"	2,775.36
T. 37 N., R. 17 E., corner of secs. 11, 12, 13, and 14; point on section stone marked "2763"	2,766.90
T. 37 N., R. 17 E., corner of secs. 13, 14, 23, and 24, 4 feet south of section corner; iron post stamped "2753"	2,756.737
T. 37 N., R. 17 E., quarter corner between secs. 23 and 24; point on section stone marked "2761"	2,764.86
T. 37 N., R. 17 E., quarter corner between secs. 35 and 36; top of corner stone marked "2716"	2,720.19
T. 36 N., R. 17 E., about sec. 1, 4 feet south of standard corner secs. 35 and 36 of surveyed township 37; iron post stamped "2695"	2,698.809
T. 36 N., R. 17 E., 1 mile south of northeast corner, top of hill, 400 feet south of coulee; point on top of stone marked "2700"	2,703.75

	Feet.
T. 36 N., R. 18 E., about SW. ¼ sec. 18, on range line, top of big hill; iron post stamped "2688"	2,693.380
T. 36 N., R. 18 E., about SW. ¼ sec. 31, 0.6 mile south of road, 0.3 mile north of road, 300 feet east of coulee; iron post stamped "2622"	2,626.910
T. 35 N., R. 18 E., about SW. ¼ sec. 18, 0.3 mile south of West Fork Creek, top of hill near wire fence; iron post stamped "2607"	2,611.460
Tps. 34 and 35 N., R. 18 E., quarter corner between secs. 6 and 31; iron post stamped "2664 HAVRE"	2,670.113
Quarter corner between secs. 6 and 31, Tps. 34 and 35 N., R. 20 E., north along range line to sec. 2, T. 37 N., R. 19 E.	
Tps. 34 and 35 N., R. 20 E., quarter corner between secs. 6 and 31; iron post stamped "2789 HAVRE"	2,795.184
Tps. 34 and 35 N., Rs. 19 and 20 E., top of township corner stone	2,770.80
T. 35 N., R. 19 E., 1,000 feet west of quarter corner on east side of sec. 24, 800 feet north of old road; iron post stamped "2712"	2,718.346
T. 35 N., R. 19 E., 0.5 mile southwest of northeast corner of sec. 1, 0.6 mile north of Choteau Coulee, at top of hill; iron post stamped "2724"	2,730.271
T. 36 N., R. 19 E., about center of sec. 24, 300 feet northeast of small coulee; iron post stamped "2709"	2,715.485
T. 36 N., R. 19 E., about south side of sec. 1, 0.4 mile north of Corral Coulee, 0.2 mile south of lake; iron post stamped "2719"	2,724.863
T. 37 N., R. 19 E., about sec. 23, near wire fence, 900 feet southwest of east corner of, 530 feet south of big coulee; iron post stamped "2746"	2,751.727
Sec. 2, T. 37 N., R. 19 E., east along Canadian line to sec. 5, T. 37 N., R. 21 E.	
T. 37 N., R. 20 E., about sec. 6, 60 feet north of United States and Canada boundary line; point on top of iron pin (Canadian section corner) marked "2813"	2,819.50
T. 37 N., R. 20 E., about sec. 5, on United States and Canada boundary line; southwest corner of monument, marked "2794"	2,800.39
T. 37 N., R. 20 E., about sec. 5, on United States and Canada boundary line, 60 feet south of Canadian section corner; iron post stamped "2790"	2,796.074
T. 37 N., R. 20 E., about sec. 4, on United States and Canada boundary line, 0.3 mile west of monument; point on iron stake (Canadian section corner) marked "2804"	2,810.48
T. 37 N., R. 20 E., about center of north side of, on United States and Canada boundary line; southwest corner of monument, marked "2815"	2,820.87
T. 37 N., R. 20 E., about sec. 3, on United States and Canada boundary line, 0.6 mile east of monument; point on iron pin (Canadian section corner) marked "2829"	2,835.19
T. 37 N., R. 20 E., about sec. 2, 600 feet east of coulee, on prominent knoll, on United States and Canada boundary line, 6 feet south of monument; iron post stamped "2883"	2,888.807
T. 37 N., R. 21 E., about sec. 6, 0.7 mile west of monument; point on iron pin (Canadian section corner) marked "2962"	2,967.80

Denton, Dog Creek, Judith, and Lewiston Quadrangles.

FERGUS COUNTY.

The elevations in the following list are based on bench mark 33/1 of the Missouri River Commission at Judith Landing, the elevation of which is accepted as 2,420.506 feet, a figure 4 feet higher than that published in the annual report of the Chief of Engineers, United States Army, for 1894. Orthometric corrections have been applied.

The leveling was done in 1905 by F. E. Fellows.

DENTON QUADRANGLE.

Point near Kendall electric power house along road northwest to Denton, thence northeast to open prairie.

	Feet.
Kendall, 5.3 miles northwest of electric power house, 600 feet southeast of schoolhouse, 130 feet south of Grinnel's house, north of road; iron post stamped "3597 BUTTE"	3,600.208
Kendall, 7.5 miles northwest of electric power house, south side of forks of road, 80 feet south of gate of Bank ranch; iron post stamped "3547 BUTTE"	3,550.193
Deerfield, 2.9 miles northwest of, 160 feet northwest of bridge crossing Judith River, 70 feet north of road, 20 feet east of gate; iron post stamped "3232 BUTTE"	3,235.183
Deerfield, 5.8 miles northwest of, 0.3 mile southeast of summit, 25 feet south of road; iron post stamped "3666 BUTTE"	3,669.187
Denton, 2.7 miles southeast of, 1 mile west of log cabin, 30 feet north of road; iron post stamped "3594 BUTTE"	3,597.172
Denton, 0.4 mile northeast of, jog in fence line on east side of road, at fence corner; iron post stamped "3512 BUTTE"	3,515.161
Denton, 3.6 miles northeast of, 0.2 mile south of log house, 15 feet east of road; iron post stamped "3586 BUTTE"	3,589.158
Denton, 6.6 miles northeast of, 20 feet east of road, top of mesa; iron post stamped "3737 BUTTE"	3,740.151
Denton, 10.1 miles northeast of, 10 feet east of road, top of mesa; iron post stamped "3671 BUTTE"	3,674.139
Denton, 13.6 miles northeast of, 25 feet west of road, top of mesa; iron post stamped "3628 BUTTE"	3,631.124

DOG CREEK QUADRANGLE.

Point 7 miles southeast of Judith south to open prairie.

Judith, 9.9 miles southeast of, 200 feet west of top of ridge, 20 feet north of road, in top of sandstone bowlder; bronze tablet stamped "3451 BUTTE"	3,453.945
Judith, 12.8 miles southeast of, 1 mile north of Brown's ranch, 20 feet northeast of road; iron post stamped "3387 BUTTE"	3,390.029
Judith, 16 miles southeast of, 25 feet west of road, in open prairie; iron post stamped "3441 BUTTE"	3,444.034
Judith, 19.9 miles southeast of, 470 feet west of log house, 170 feet west of gate; iron post stamped "3277 BUTTE"	3,280.049
Judith, 22.7 miles southeast of, 20 feet west of road, in open prairie, iron post stamped "3459 BUTTE"	3,462.079

JUDITH QUADRANGLE.

Judith southeast along roads 7 miles via Christina to Horseshoe Bar ranch.

Judith Landing, in northwest corner of J. R. Norris's front yard on right bank of river; inside iron post, at bottom (Missouri River Commission bench mark 33/1)	2,420.506
Judith, 3.8 miles southeast of, 200 feet west of head of gulch, 15 feet south of road; iron post stamped "3150 BUTTE"	3,152.993
Judith, 7 miles southeast of, 20 feet east of road, 8 feet east of gate, 2 feet north of wire fence; iron post stamped "3247 BUTTE"	3,249.997

Open prairie north along highway to Judith.

	Feet.
Denton, 16.6 miles northeast of, 25 feet east of road, in open prairie; iron post stamped "3570 BUTTE"	3,573.
Everson, 4.2 miles south of, 1 foot west of corner of secs. 22, 23, 26, and 27, T. 21 N., R. 15 E., 50 feet south of corner of wire fence; iron post stamped "3551 BUTTE"	3,554.
Everson, 0.2 mile southwest of, 400 feet south of coulee, 20 feet east of road, in sandstone 6 by 12 by 20 inches set 16 inches in ground; bronze triangulation tablet stamped "3298 BUTTE"	3,301.
Everson, 3.3 miles northeast of, 650 feet southeast of corner of wire fence, in sandstone 12 by 16 by 16 inches; aluminum tablet stamped "2793 BUTTE"	2,796.
Everson, 6.6 miles northeast of, 0.2 mile west of Judith River, 600 feet north of mouth of coulee; iron post stamped "2525 BUTTE"	2,528.
Judith, 2.5 miles southwest of, 150 feet east of irrigating ditch, 20 feet east of road, on point of bench; iron post stamped "2484 BUTTE"	2,487.

LEWISTON QUADRANGLE.

Open prairie south along road to point 2 miles west of Kendall electric plant.

Judith, 26 miles southeast of, 25 feet east of road, 10 feet west of wire fence, 0.5 mile north of Stevens's ranch, east point of ridge; iron post stamped "3391 BUTTE"	3,394.
Judith, 29.2 miles southeast of, 0.5 mile northwest of Cook ranch house, 50 feet east of road, top of slight ridge; iron post stamped "3481 BUTTE"	3,484.
Christina, 1.1 miles north of, 800 feet northwest of board shack, 400 feet south of drain, 30 feet east of road; iron post stamped "3561 BUTTE"	3,564.
Christina, 1.6 miles south of, 250 feet south of gate, 30 feet west of road; iron post stamped "3641 BUTTE"	3,644.
Christina, 4.9 miles south of, 0.5 mile west of cabin, 40 feet west of road; iron post stamped "3778 BUTTE"	3,781.
Christina, 8.6 miles south of, 0.2 mile north of forks of road leading west to Kendall, top of ridge, 2 feet east of wire fence; iron post stamped "4205 BUTTE"	4,208.
Christina, 11.6 miles south of, 0.2 mile north of forks of road, 25 feet south of gate, 20 feet east of road; iron post stamped "4069 BUTTE"	4,072.
Log schoolhouse, 0.2 mile southeast of, east of road, turn in telephone line at forks of road, 1 foot west of wire fence; iron post stamped "4036 BUTTE"	4,039.
Horseshoe Bar ranch house, 0.5 mile southeast of, 150 feet south of forks of road, at northeast corner of white house; iron post stamped "3776 BUTTE"	3,779.
Kendall, 2.2 miles west of electric power house, 100 feet south of irrigating canal, 20 feet south of gate at forks of road; iron post stamped "3693 BUTTE"	3,696.

Blackfoot, Chouteau, Collins, Conrad, Cutbank, Dupuyer, Galata, Goodale, Hes Butte, Hogan, Saypo, and Sweetgrass Quadrangles.

CASCADE, LEWIS AND CLARK, AND TETON COUNTIES.

The elevations in the following list were determined by primar leveling forming part of a net extending from Butte to the Unite States and Canada boundary line. They accord with preliminar

adjustment values of 1911 for bench marks of the Coast and Geodetic Survey precise-level line in the vicinity of Butte. An orthometric correction has been applied between Butte and the boundary.

The leveling by the United States Geological Survey was done in the Blackfoot quadrangle in 1901 by Goyne Drummond and in 1907 by H. G. Parry; in the Chouteau quadrangle in 1901 by S. H. Martin; in the Collins quadrangle in 1900 by S. H. Martin; in the Cutbank quadrangle in 1907 and 1909 by H. G. Parry; in the Dupuyer quadrangle in 1901 by S. H. Martin; in the Goodale quadrangle in 1900 by S. H. Martin; in the Heart Butte quadrangle in 1904 by G. H. Kendall; in the Hogan quadrangle in 1900 and 1901 by S. H. Martin; and in the Saypo quadrangle in 1901 by S. H. Martin. Leveling by the Reclamation Service was done in 1901 in the Blackfoot and Sweetgrass quadrangles; in 1901, 1902, and 1905 in the Cutbank quadrangle; in 1903 in the Conrad and Galata quadrangles; and in 1905 in the Blackfoot, Chouteau, Collins, Hogan, and Saypo quadrangles; leveling by the United States and Canada Boundary Survey in 1910 in the Blackfoot and Cutbank quadrangles.

BLACKFOOT QUADRANGLE.

Browning east along highway to Blackfoot, thence northwest along main road to Greasewood Creek.

	Feet.
Browning, 3.8 miles east of agency, 0.4 mile south of road, 30 feet north of house; iron post stamped "4243 GN"	4,252.880
Blackfoot, 150 feet south of water tank; iron post stamped "4149 GN"	4,158.808
Blackfoot, 3 miles northwest of, 2 miles north of forks of road, 60 feet east of road; iron post stamped "4259 GN"	4,268.697
Blackfoot, 6 miles northwest of, 400 feet south of Cutbank Creek, 150 feet east of house; iron post stamped "4181 GN"	4,190.893

Greasewood Creek east to southeast corner of T. 34 N., R. 11 W., thence north 6 miles, east 12 miles, north 12 miles, and west 15 miles to T. 37 N., R. 11 W.

T. 33 N., R. 11 W., northeast corner of; iron post stamped "4201"	4,203.544
T. 34 N., R. 11 W., quarter corner on east side of sec. 13, 2 feet south of corner stone; iron post stamped "4354"	4,356.051
T. 34 N., R. 11 W., 3 feet east of northeast corner of; iron post stamped "4399"	4,401.064
T. 34 N., R. 10 W., near northeast corner of sec. 4, 300 feet west of creek, 1,500 feet southwest of corral; iron post stamped "4210"	4,211.982
T. 34 N., R. 10 W., northeast corner of; iron post stamped "4246"	4,247.742
T. 34 N., R. 9 W., northeast corner of sec. 4; iron post stamped "4413"	4,415.232
T. 34 N., R. 9 W., northeast corner of; iron post stamped "4215"	4,217.304
T. 35 N., R. 9 W., northeast corner of sec. 24, in corner stone; aluminum tablet stamped "4403"	4,404.807
T. 35 N., R. 9 W., northeast corner of; iron post stamped "4126"	4,128.328
T. 36 N., R. 9 W., northeast corner of sec. 13; iron post stamped "4140"	4,141.997
T. 37 N., R. 9 W., southeast corner of, standard corner at intersection of second guide meridian and 9th standard parallel; iron post stamped "4256"	4,258.429

	Feet.
T. 36 N., R. 9 W., northeast corner of, closing corner at intersection of second guide meridian and 9th standard parallel; iron post stamped "4235"	4,236.679
T. 37 N., R. 9 W., southeast corner of sec. 34; iron post stamped "4128"	4,129.960
T. 36 N., R. 10 W., northeast corner of, closing corner of 9th standard parallel; iron post stamped "4172"	4,173.788
T. 37 N., R. 10 W., southeast corner of, standard corner of 9th standard parallel; iron post stamped "4163"	4,165.368
T. 37 N., R. 11 W., southeast corner of; iron post stamped "4525"	4,526.613

Northeast corner of T. 35 N., R. 9 W., east 5 miles, thence south 0.3 mile to Reclamation Service bench mark 700 feet northwest of fork of coulee.

T. 35 N., R. 8 W., northeast corner of sec. 4; iron post stamped "4023"	4,024.932
T. 35 N., R. 8 W., about sec. 2, 700 feet northwest of fork of coulee, 3 miles southeast of Clay Butte; iron post	4,017.388

Northeast corner of sec. 2, T. 35 N., R. 8 W., east 3 miles.

T. 35 N., R. 8 W., northeast corner of; iron post stamped "3995.6"	3,997.574
T. 35 N., R. 7 W., 3 feet east of northeast corner of sec. 4; iron post stamped "3993"	3,994.913

Northeast corner of T. 32 N., R. 7 W., west along township line to Blackfoot.

T. 33 N., R. 7 W., 3 feet east of southeast corner of sec. 32; iron post stamped "3956"	3,959.468
T. 32 N., R. 8 W., northeast corner of, closing corner of 8th standard parallel; iron post stamped "4007"	4,010.510
T. 33 N., R. 8 W., southeast corner of, standard corner of 8th parallel; General Land Office iron post stamped "3987"	3,990.118
T. 33 N., R. 8 W., 520 feet S. 40° E. of southeast corner of sec. 34, on side of hill 500 feet north of large lake; iron post stamped "3973"	3,976.412
T. 32 N., R. 9 W., northeast corner of, closing corner of 8th standard parallel; iron post stamped "4183"	4,186.119
T. 33 N., R. 9 W., southeast corner of, standard corner of 8th standard parallel; iron post stamped "4161"	4,164.467
T. 33 N., R. 9 W., 315 feet S. 39° 30′ E. from southeast corner of sec. 33 (magnetic bearing), in large conglomerate stone; aluminum tablet stamped "4194"	4,197.487
T. 32 N., R. 10 W., northeast corner of, closing corner of 8th standard parallel; iron post stamped "4105"	4,108.409
T. 33 N., R. 10 W., southeast corner of, standard corner of 8th standard parallel; iron post stamped "4111"	4,114.226

Standard bench marks in the Blackfoot quadrangle established by the Reclamation Service.

T. 36 N., R. 10 W., sec. 19, 0.6 mile south of South Fork of Milk River, 600 feet west of McLeod road; iron post stamped "4418 GN"	4,428.472
T. 36 N., R. 10 W., sec. 22, 1.3 miles south of South Fork of Milk River, 3 miles east of McLeod road; iron post stamped "4414 GN"	4,424.524
T. 36 N., R. 9 W., sec. 16, 600 feet south of divide between South Fork of Milk River and Cutbank Creek, 20 feet east of Croff's ranch road to Browning; iron post stamped "4400 GN"	4,410.406
T. 36 N., R. 8 W., sec. 21, about 4 miles south of Landslide triangulation station, 0.6 mile north of Chalk Buttes; iron post stamped "4183 GN"	4,193.554
T. 37 N., R. 7 W., sec. 32, on top of head of west bluff of Rocky Coulee, 2 miles south of South Fork of Milk River; iron post stamped "4170 GN"	4,180.687

Point 6 miles northwest of Blackfoot east along Cutbank Creek to Allison ranch (unadjusted line closing 1 foot low).

	Feet.
Blackfoot, 6 miles northwest of, 400 feet south of Cutbank Creek, 150 feet east of house; iron post stamped "4181 GN"	4,190.893
T. 34 N., R. 8 W., sec. 31, along trail on flat between Cabell's and Perrine's ranches, 0.9 mile west of Perrine's house, on east side of north and south fence; iron post	3,924.540
T. 35 N., R. 8 W., about sec. 2, 2,700 feet northwest of fork of coulee, 3 miles southeast of Clay Butte; iron post	4,017.388

Divide between Little and Big Rocky coulees west to sec. 8, T. 35 N., R. 7 W.

T. 35 N., R. 7 W., about NW. ¼ sec. 9, 1 mile northeast of Little Rocky Coulee, 1 mile southwest of divide; iron post	3,937.545

Sec. 2, T. 37 N., R. 11 W., east along United States and Canada boundary to sec. 3, T. 37 N., R. 7 W.

T. 37 N., R. 11 W., sec. 1, 10 feet west of monument 370; standard Boundary Survey post	4,298.363
T. 37 N., R. 10 W., northwest corner of sec. 6; General Land Office standard post	4,306.872
T. 37 N., R. 10 W., northwest corner of sec. 5; point on section stone	4,388.46
T. 37 N., R. 10 W., north side of sec. 5, at monument 369A, in south side of foundation; bronze tablet	4,513.109
T. 37 N., R. 10 W., northwest corner of sec. 4; top of section stone	4,597.61
T. 37 N., R. 10 W., sec. 4, in south side of foundation of monument 369; bronze tablet	4,492.470
T. 37 N., R. 10 W., northwest corner of sec. 3; point on top of section stone	4,472.27
T. 37 N., R. 10 W., sec. 2, in south side of foundation of monument 368A; bronze tablet	4,486.211
T. 37 N., R. 10 W., northwest corner of sec. 1, south of corner stone; top of iron stake	4,437.25
T. 37 N., R. 9 W., 800 feet west of northeast corner of sec. 6, in south side of foundation of monument 368; bronze tablet	4,448.526
T. 37 N., R. 9 W., northwest corner of sec. 6; iron post	4,431.696
T. 37 N., R. 9 W., northwest corner of sec 5, south of section stone; iron stake	4,352.96
T. 37 N., R. 9 W., sec. 5, in south side of foundation of monument 367B; bronze tablet	4,369.710
T. 37 N., R. 9 W., northwest corner of sec. 4; point on top of section stone	4,342.84
T. 37 N., R. 9 W., sec. 4, in south side of foundation of monument 367A; bronze tablet	4,340.162
T. 37 N., R. 9 W., northwest corner of sec. 3; point on top of section stone	4,338.60
T. 37 N., R. 9 W., northeast corner of sec. 2; top of section stone	4,333.84
T. 37 N., R. 9 W., 990 feet west of northeast corner of sec. 3, at monument 367; iron post	4,349.686
T. 37 N., R. 9 W., quarter corner on north side of sec. 6; iron stake	4,145.89
T. 37 N., R. 9 W., sec. 1, south side of foundation of monument 366A; iron post	4,123.142
T. 37 N., R. 8 W., northwest corner of sec. 6; General Land Office iron post	4,059.751
T. 37 N., R. 8 W., northwest corner of sec. 5; top of section stone	4,023.00

	Feet.
T. 37 N., R. 8 W., sec. 5, south side of foundation of monument 366; Boundary Survey iron post	4,059.171
T. 37 N., R. 8 W., northwest corner of sec. 4; top of section stone	3,986.90
T. 37 N., R. 8 W., sec. 4, south side of foundation of monument 365A; Boundary Survey iron post	4,007.605
T. 37 N., R. 8 W., northwest corner of sec. 3; top of section stone	4,005.42
T. 37 N., R. 8 W., northwest corner of sec. 2; top of section stone	3,992.23
T. 37 N., R. 8 W., sec. 2, in south side of foundation of monument 365; Boundary Survey iron post	4,053.488
T. 37 N., R. 8 W., northwest corner of sec. 1; top of section stone	3,995.99
T. 37 N., R. 8 W., sec. 31, in south side of monument 364A; Boundary Survey iron post	3,985.947
T. 37 N., Rs. 7 and 8 W., secs. 1 and 6, at township corner; iron post	3,951.517
T. 37 N., R. 7 W., northwest corner of sec. 5; top of section stone	3,929.55
T. 37 N., R. 7 W., near northwest corner of sec. 5, south side of monument 364; Boundary Survey iron post	3,925.969
T. 37 N., R. 7 W., 2,450 feet east of northwest corner of sec. 5, at foot of hill, west bank of Milk River, north side of lane; point on large stone	3,893.22
T. 37 N., R. 7 W., northwest corner of sec. 4; top of section stone	3,931.62
T. 37 N., R. 7 W., in south side of foundation of monument 363A; bronze tablet	3,966.589
T. 37 N., R. 7 W., northwest corner of sec. 3; point on section stone	3,974.14
T. 37 N., R. 7 W., 1,600 feet east of northwest corner of sec. 3; point on stone	3,967.43

CHOUTEAU QUADRANGLE.

Belleview east along highway to Chouteau.

Belleview, at large gate entrance to C. W. Gray's residence and post office; iron post stamped "4343 BUTTE"	4,346.058
Belleview, 2.8 miles east of, corner of fenced ranch, at angle of road near point where road leaves Willow Creek; iron post stamped "4260 BUTTE"	4,262.877
Belleview, 6 miles east of, on open prairie at foot of grade east side of hill; iron post stamped "4141 BUTTE"	4,144.223
Chouteau, 6.25 miles west of, top of small hill, on north side of road, at angle; iron post stamped "4105 BUTTE"	4,108.145
Chouteau, 3.25 miles west of, near top of grade going west from Chouteau; iron post stamped "4000 BUTTE"	4,003.213
Chouteau, at left entrance to Teton County jail; iron post stamped "3810 BUTTE"	3,813.226

Chouteau south along wagon road to Augusta.

Chouteau, 1.5 miles south of, at top of southeast steel pier of iron bridge across Teton River; chiseled cross	3,779.34
Chouteau, 3.8 miles south of, in corner of fence, at foot of bluff; iron post stamped "3959 BUTTE"	3,962.262
Chouteau, 7.5 miles south of, top of grade on top of big butte south of Chouteau; iron post stamped "4501 BUTTE"	4,504.307
Chouteau, 10.66 miles south of, east side of road, south of coulee; iron post stamped "4560 BUTTE"	4,563.214
Chouteau, 13.8 miles south of, east of road, south of coulee; iron post stamped "4617 BUTTE"	4,620.520
Augusta, 10.35 miles north of, 300 feet east of small lake, northeast corner of fenced ranch; iron post stamped "4368 BUTTE"	4,371.142

	Feet.
Augusta, 6.8 miles north of, west side of road, about 1,000 feet from grade crossing of flat; iron post stamped "4247 BUTTE"	4,250.171
Augusta, 4.2 miles north of, 75 feet north of north end of bridge across North Fork of Sun River; iron post stamped "3973 BUTTE"	3,976.391
Augusta, 2.66 miles north of, east side of road near top of grade; iron post stamped "4130 BUTTE"	4,133.136

Bynum south along stage road to Chouteau.

Bynum, 500 feet in front of general store and post office, at fence corner; iron post stamped "3981 BUTTE"	3,983.981
Bynum, 3 miles south of, at corner of fenced ranch; iron post stamped "3960 BUTTE"	3,963.649
Bynum, 6.3 miles south of, about 1,200 feet south of large irrigating ditch; iron post stamped "4022 BUTTE"	4,024.919
Chouteau, 5.2 miles north of, top of grade, at point where road comes out of Teton River Valley, corner of section line; iron post stamped "4005 BUTTE"	4,007.645
Chouteau, 1.2 miles north of, north end of fence corner of ranch in valley between Spring Creek and Teton River, west side of road; iron post stamped "3894 BUTTE"	3,896.459

Sun River project, Teton slope canal line, located in Tps. 23 and 24 N., Rs. 3, 4, and 5 W., by Reclamation Service.[1]

T. 23 N., R. 5 W., along wire fence line, 75 feet north of corral; iron post stamped "BUTTE 3897"	3,900.049
T. 23 N., Rs. 4 and 5 W., east quarter corner between secs. 12 and 7; iron post stamped "BUTTE 3882"	3,885.186
T. 23 N., R. 4 W., third telephone post, fifth post up fence from angle; iron post stamped "BUTTE 3846"	3,849.304
T. 23 N., R. 4 W., at east gate post, 50 feet south of flume; iron post stamped "BUTTE 3820"	3,823.209
T. 23 N., R. 4 W., corner of secs. 2, 3, 10, and 11; iron post stamped "BUTTE 3797"	3,800.446
T. 23 N., R. 4 W., corner between secs. 1 and 2; iron post stamped "BUTTE 3795"	3,797.924
Tps. 23 and 34 N., R. 4 W., corner of secs. 35, 36, 1, and 2; iron post stamped "BUTTE 3858"	3,860.830
T. 24 N., R. 3 W., southwest corner of sec. 31; iron post stamped "BUTTE 3825"	3,828.105
T. 24 N., R. 3 W., quarter corner between secs. 32 and 33; iron post stamped "BUTTE 3829"	3,832.128

Sun River project, north side diversion line.[1]

T. 22 N., R. 7 W., 1,500 feet west and 1,530 feet north of southeast corner of sec. 3; iron post stamped "BUTTE 4376"	4,379.198
T. 22 N., R. 7 W., quarter corner between secs. 23 and 24, 0.5 mile north of Christian's shearing shed, on line stone of Johnnie reservoir No. 2; iron post stamped "BUTTE 4330"	4,333.017

[1] A correction of 3.1 feet has been added to the Reclamation Service values.

COLLINS QUADRANGLE.

Augusta east to Great Falls (portion of line).[1]

Hefler, in front of post office, at gate entrance to dwelling; iron post..... 3,591.
Hefler, 3 miles east of, gate at west entrance to fenced portion of Fort Shaw Indian Reservation, 200 feet south of Sun River; iron post..... 3,536.
Fort Shaw Indian school, in jamb of south door of blacksmith shop of manual training shop; aluminum tablet..... 3,501.
Fort Shaw, 3 miles east of, on Great Falls–Augusta road, north side of road north, west of mouth of gulch and small bridge; iron post..... 3,459.
Sun River, in center of plaster base of Sun River Mercantile Co.'s store; aluminum tablet..... 3,409.
Sun River, 3.2 miles east of, in front of P. H. Rowl's residence; iron post.. 3,381.
Sunnyside, 65 feet southeast of Sunnyside Store Co.'s store building; iron post..... 3,346.
Sunnyside, 3 miles east of, south foot of hill, between telephone poles 306 and 307; iron post..... 3,380.

Sun River project, Teton slope canal line, located in T. 24 N., Rs. 1 E., 1, 2, and 3 W., by Reclamation Service.[2]

T. 24 N., R. 3 W., quarter corner between secs. 21 and 22; iron post stamped "BUTTE 3787"..... 3,789.
T. 24 N., R. 3 W., corner of secs. 16, 15, 21, and 22; iron post stamped "BUTTE 3768"..... 3,771.
T. 24 N., R. 3 W., corner of secs. 10, 11, 14, and 15; iron post stamped "BUTTE 3791"..... 3,793.
T. 24 N., Rs. 2 and 3 W., quarter corner between secs. 13 and 18; iron post stamped "BUTTE 3795"..... 3,797.
T. 24 N., R. 2 W., corner of secs. 17, 18, 19, and 20; iron post stamped "BUTTE 3801"..... 3,803.
T. 24 N., R. 2 W., quarter corner between secs. 15 and 16; iron post stamped "BUTTE 3798"..... 3,801.
T. 24 N., R. 2 W., quarter corner between secs. 13 and 14; iron post stamped "BUTTE 3787"..... 3,789.
T. 24 N., R. 1 W., quarter corner between secs. 17 and 18; iron post stamped "BUTTE 3784"..... 3,787.
T. 24 N., R. 1 W., quarter corner between secs. 16 and 17; iron post stamped "BUTTE 3778"..... 3,781.
T. 24 N., R. 1 W., corner of secs. 14, 15, 22, and 23; iron post stamped "BUTTE 3779"..... 3,782.
T. 24 N., R. 1 W., 68 feet south of corner of secs. 23, 24, 25, and 26; iron post stamped "BUTTE 3777"..... 3,780.
T. 24 N., R. 1 W., southeast corner of sec. 25; iron post stamped "BUTTE 3704"..... 3,707.
T. 24 N., R. 1 E., quarter corner between secs. 31 and 32; iron post stamped "BUTTE 3736"..... 3,739.

CONRAD QUADRANGLE.

Shelby east along Great Northern Ry. 4 miles and south along highway to Conrad, thence east to sec. 32, T. 31 N., R. 1 E.

Shelby, 4 miles east of, 6 miles north of Farrell, 50 feet north of Great Northern Railway; iron post stamped "3365 GN"..... 3,375.

[1] This line is based upon adjusted elevation at Augusta, and is not adjusted on account of closure en of −5.727 feet upon corrected elevations at Great Falls.

[2] A correction of 3.1 feet has been added to the Reclamation Service values.

	Feet.
Bridge 96, Great Falls & Canada division, Great Northern Railway, south side of, at west end; 60-penny nail on cap	3,128.30
Conrad, at sectionhouse, sec. 8, T. 30 N., R. 1 W.; spike in telephone pole.	3,046.22
Conrad, 1,000 feet north of water tank, on hill; iron post	3,089.928
T. 31 N., R. 1 E., sw. ¼ sw. ¼ sec. 32; 0.3 mile north of Barney & Marsh ranch; iron post	3,092.956

CUTBANK QUADRANGLE.

Northeast corner of sec. 4 east 3 miles, thence south 1 mile to point near northeast corner of sec. 12, T. 35 N., R. 7 W.

T. 35 N., R. 7 W., northeast corner of; General Land Office iron post stamped "3930"	3,931.728
T. 35 N., R. 7 W., 400 feet south of northeast corner of sec. 12, 300 feet east of road, 20 feet west of creek, in Big Rocky Coulee; iron post stamped "3838" (set by Reclamation Service)	3,840.246

Northeast corner of T. 31 N., R. 6 W., north 6 miles, thence west along eighth standard parallel to T. 32 N., R. 7 W.

T. 32 N., R. 6 W., N. 7° W. from southeast corner of sec. 13, on flat 0.5 mile west of Cutbank Creek, 100 feet south of coulee, in top of stone 20 by 14 by 12 inches; aluminum tablet stamped "3665"; location marked by large monument	3,668.885
T. 32 N., R. 6 W., northeast corner, closing corner of 8th standard parallel; General Land Office iron post stamped "3712"	3,715.638
T. 33 N., R. 6 W., southeast corner, standard corner of 8th standard parallel; General Land Office iron post stamped "3712"	3,715.157
T. 33 N., R. 6 W., southeast corner of sec. 33, in top of section stone; alluminum tablet stamped "3735"	3,738.752
T. 32 N., R. 7 W., northeast corner of, closing corner of 8th standard parallel; General Land Office iron post stamped "3859"	3,862.680
T. 33 N., R. 7 W., southeast corner of, standard corner of 8th standard parallel; General Land Office iron post stamped "3862"	3,865.778

Allison's ranch east down Cutbank Creek to Cutbank, thence southeast along Great Northern Ry. to point near Ethridge.

Cutbank, sec. 1, T. 33 N., R. 6 W., 600 feet north of station, 600 feet southeast of house on north side of track; iron post	3,751.363
Baltic, 0.5 mile north of, sec. 17, T. 33 N., R. 5 W., on top of divide 500 feet north of railroad; iron post	3,897.700
T. 33 N., R. 5 W., sec. 23, 500 feet northwest of west end of snow fence, on small butte between two coulees; iron post	3,752.980
T. 33 N., R. 4 W., about south side of sec. 35, 1 mile west of water tank, 0.75 mile south of big cut, 600 feet north of track; iron post	3,598.988

Allison's ranch north up Little Rocky Coulee 3.5 miles.

T. 35 N., R. 7 W., 3.5 miles north of Cutbank Creek, on Little Rocky Coulee; iron post	3,799.611

Upper Big Rocky Coulee north from mouth to northeast corner of sec. 12, T. 35 N., R. 7 W., thence west to divide.

T. 34 N., R. 6 W., north side of sec. 9, on left side of draw entering Big Rocky Coulee where coulee makes turn to east; iron post	3,776.944
T. 35 N., R. 6 W., NE. ¼ sec. 21, on small flat 800 feet from creek opposite mouth of big coulee coming in from right; iron post	3,859.483

	Feet.
T. 35 N., R. 7 W., 400 feet south of northeast corner of sec. 12, 700 feet southeast of small butte, 1 mile north of bend, 1,000 feet west of gap, 300 feet east of road, 20 feet west of creek; iron post	3,840.246
Coyote Springs, 0.5 mile northwest of, 300 feet northwest of fork of creek, on point of small butte; iron post	3,877.877

Reservation line east along section line 1 mile north of south boundary of T. 34 N. to quarter corner on south side of sec. 26, T. 34 N., R. 5 W.

T. 34 N., R. 5 W., 500 feet west of quarter corner on south side of sec. 26, on top of small butte on north side of sec. 35, marked by pile of rocks; iron post	3,919.882

Reservation line east along south side of T. 35 N. to quarter corner on south side of sec. 33, T. 35 N., R. 5 W., thence north 1 mile to sec. 28, T. 35 N., R. 5 W. (unadjusted spur).

T. 35 N., R. 5 W., south side of sec. 33, on point of small butte 350 feet northeast of quarter corner on right side of coulee; iron post	3,945.911
T. 35 N., R. 5 W., sec. 28, near center, on canal line surveyed in 1902 by Drummond; iron post (Drummond's elevation 3,963.209 feet; uncorrected elevation. Record of his 1902 line lost in mail)	3,971.904

T. 37 N., R. 7 W., east along Milk River canal route to point on railroad south of Coutts.

T. 36 N., R. 6 W., 600 feet north of quarter corner on east side of sec. 8, 4 miles south of Emerson's ranch, 100 feet west of road to Cutbank; iron post stamped "4025 GN"	4,035.759
T. 36 N., R. 6 W., sec. 14, 30 feet northeast of Don Leach's house; iron post stamped "4023 GN"	4,033.557
T. 37 N., R. 4 W., sec. 32, 1,000 feet north of township line, 2 miles north of Fitzpatrick's ranch, 20 feet west of road to Coutts, Canada; iron post stamped "3949 GN" (redetermined in 1909)	3,959.768

Sec. 32, T. 33 N., R. 4 W., east 4 miles to northwest corner of T. 33 N., R. 3 W., thence north along highways to northwest corner of T. 36 N., R. 3 W., thence west to sec. 32, T. 37 N., R. 4 W.

T. 33 N., R. 4 W., south side of sec. 35, 1 mile west of water tank, 0.8 mile south of big cut, 600 feet north of track; iron post	3,598.988
Ethridge, 0.5 mile northeast of water tank, at head of dry lake; point on sandstone bowlder 24 by 24 by 12 inches; marked by reference monument	3,530.73
T. 33 N., R. 4 W., quarter corner of sec. 34; top of corner stone	3,522.45
T. 33 N., R. 4 W., standard corner of secs. 34 and 35; top of stone	3,524.28
T. 32 N., R. 4 W., closing corner of secs. 3 and 4; top of stone	3,516.14
T. 33 N., R. 4 W., 30 feet S. 70° W. of standard quarter corner of sec. 35; point on sandstone 8 by 14 by 4 inches above ground; marked by reference monument	3,525.50
T. 33 N., R. 4 W., standard corner of secs. 35 and 36; top of stone	3,520.28
T. 32 N., R. 4 W., closing corner of secs. 1 and 2; top of stone	3,516.98
T. 33 N., R. 4 W., 20 feet north of standard quarter corner of sec. 36; top of granite bowlder; monument	3,527.31
T. 33 N., Rs. 3 and 4 W., standard corner; top of stone	3,522.94
T. 32 N., Rs. 3 and 4 W., corner of; iron post stamped "3514"	3,515.625
T. 33 N., R. 4 W., quarter corner between secs. 36 and 31; top of stone	3,517.94
T. 33 N., Rs. 3 and 4 W., corner of secs. 25, 36, 30, and 31; top of corner stone	3,523.90

	Feet.
T. 33 N., Rs. 3 and 4 W., quarter corner between secs. 25 and 30; top of stone	3,523.71
T. 33 N., Rs. 3 and 4 W., corner of secs. 24, 25, 19, and 30; top of corner stone	3,479.78
T. 33 N., Rs. 3 and 4 W., 2 feet south of corner of secs. 18, 24, 13, and 19; iron post stamped "3382"	3,383.885
T. 33 N., Rs. 3 and 4 W., corner of secs. 12, 13, 7, and 18; top of corner stone.	3,318.57
T. 33 N., Rs. 3 and 4 W., quarter corner between secs. 12 and 7; top of corner stone	3,306.31
T. 33 N., Rs. 3 and 4 W., corner of secs. 1, 12, 6, and 7; top of corner stone.	3,289.74
T. 33 N., Rs. 3 and 4 W., quarter corner between secs. 1 and 7; top of corner stone	3,299.85
Ts. 33 and 34 N., Rs. 3 and 4 W., corner of; iron post stamped "3295"	3,296.926
T. 34 N., Rs. 3 and 4 W., corner of secs. 25, 26, 30, and 31; top of corner stone	3,323.08
T. 34 N., Rs. 3 and 4 W., corner of secs. 13, 24, 18 and 19; iron post stamped "3374"	3,375.910
T. 34 N., Rs. 3 and 4 W., corner of secs. 12, 13, 7, and 18; top of corner stone.	3,394.70
T. 34 N., Rs. 3 and 4 W., quarter corner between secs. 1 and 7; top of corner stone	3,388.72
Tps. 34 and 35 N., Rs. 3 and 4 W., corner of; iron post stamped "3427"	3,428.919
Tps. 33 and 34 N., R. 4 W., 6 feet south of quarter corner between secs. 2 and 35; top of granite rock	3,502.78
Davidson's ranch, 1 mile north of, on road 1 mile south of Big Spring, 0.5 mile south of road crossing in coulee, in top of bowlder; aluminum tablet stamped "3707" and marked by reference monument	3,708.708
Davidson's ranch, 1.8 miles north of, on road to Big Spring, on point of bluff, 1,000 feet south and 10° east of, 20 feet west of road; top of granite rock 14 by 18 by 16 inches above ground	3,788.21
T. 35 N., R. 4 W., quarter corner between secs. 2 and 3; top of corner stone.	4,187.92
Tps. 35 and 36 N., R. 4 W., corner of secs. 2, 3, 34, and 35; top of corner stone	4,185.85
Tps. 35 and 36 N., R. 4 W., quarter corner between secs. 2 and 35; top of corner stone	4,178.32
Tps. 35 and 36 N., R. 4 W., corner of secs. 35, 36, 2, and 1; top of corner stone	4,155.10
Tps. 35 and 36 N., Rs. 3 and 4 W., corner of secs. 36, 31, 1, and 6; iron post stamped "4191"	4,192.689
T. 36 N., Rs. 3 and 4 W., quarter corner between secs. 31 and 36; top of corner stone	4,206.93
T. 36 N., Rs. 3 and 4 W., corner of secs. 25, 30, 36, and 31; top of corner stone	4,195.33
T. 36 N., Rs. 3 and 4 W., quarter corner between secs. 25 and 30; top of corner stone	4,181.21
T. 36 N., Rs. 3 and 4 W., corner of secs. 24, 19, 30, and 35; top of corner stone	4,120.15
T. 36 N., Rs. 3 and 4 W., quarter corner between secs. 19 and 24; top of corner stone	4,059.66
T. 36 N., Rs. 3 and 4 W., corner of secs. 13, 18, 19, and 24; iron post stamped "4029"	4,030.632
T. 36 N., Rs. 3 and 4 W., quarter corner between secs. 13 and 18; top of corner stone	3,987.59

	Feet.
T. 36 N., Rs. 3 and 4 W., corner of secs. 12, 7, 18, and 13; top of corner stone	3,966.
T. 36 N., Rs. 3 and 4 W., corner of secs. 1, 6, 7, and 12; top of corner stone	3,949.
T. 36 N., Rs. 3 and 4 W., closing corner; iron post stamped "3936"	3,937.
T. 37 N., R. 4 W., standard corner; top of corner stone	3,898.
T. 37 N., R. 4 W., quarter corner between secs. 36 and 1; top of corner stone	3,872.
T. 36 N., R. 4 W., closing corner of secs. 1 and 2; top of corner stone	3,882.
T. 37 N., R. 4 W., standard corner of secs. 35 and 36; top of corner stone	3,846.
T. 37 N., R. 4 W., quarter corner between secs. 35 and 2; top of corner stone	3,879.
T. 36 N., R. 4 W., closing corner of secs. 2 and 3; top of corner stone	3,863.
T. 37 N., R. 4 W., standard corner of secs. 34 and 35; top of corner stone	3,898.
T. 37 N., R. 4 W., quarter corner between secs. 34 and 3; top of corner stone	3,927.
T. 36 N., R. 4 W., closing corner of secs. 3 and 4; top of corner stone	3,977.
T. 37 N., R. 4 W., standard corner of secs. 33 and 34; iron post stamped "3974"	3,975.
T. 36 N., R. 4 W., closing corner of secs. 4 and 5; top of corner stone	4,047.
T. 37 N., R. 4 W., standard corner of secs. 32 and 33; top of corner stone	4,066.

Sec. 35, T. 35 N., R. 4 W., west to sec. 36, T. 35 N., R. 5 W.

Tps. 34 and 35 N., R. 4 W., corner of secs. 2, 3, 34, and 35; top of corner stone	3,531.
Tps. 34 and 35 N., R. 4 W., quarter corner between secs. 34 and 3; top of corner stone	3,570.
Tps. 34 and 35 N., R. 4 W., 4 feet west of corner of secs. 3, 4, 33, and 34, iron post stamped "3554"	3,556.
Tps. 34 and 35 N., R. 4 W., corner of secs. 4, 5, 32, and 33; top of corner stone	3,563.
Tps. 34 and 35 N., R. 4 W., corner of secs. 5, 6, 31, and 32; top of corner stone	3,617.
Tps. 34 and 35 N., Rs. 4 and 5 W., corner of; iron post stamped "3689"	3,690.
Tps. 34 and 35 N., Rs. 4 and 5 W., 0.5 mile north 10° west of corner of, 0.2 mile southwest of sheep ranch, 400 feet west of and 0.5 mile north of wagon road; iron post stamped "3741" (set by G. Drummond, of Reclamation Service, in 1902; his value not known)	3,752.

Sec. 32, T. 33 N., R. 4 W., west to corner of Tps. 32 and 33 N., Rs. 4 and 5 W. (double spur line).

T. 33 N., R. 4 W., south side of sec. 35, 1 mile west of water tank, 0.8 mile south of big cut, 600 feet north of track; iron post	3,598.
T. 32 N., R. 4 W., closing corner of secs. 5 and 6; top of corner stone	3,620.
T. 33 N., R. 4 W., standard corner of secs. 31 and 32; top of corner stone	3,622.
T. 33 N., Rs. 4 and 5 W., point of ridge running east-west, 0.5 mile east of township corner; point on bowlder 8 by 10 by 14 feet above ground; marked by reference monument	3,681.
T. 32 N., Rs. 4 and 5 W., closing corner; top of stone	3,750.
T. 33 N., Rs. 4 and 5 W., standard corner of; iron post	3,782.

Sec. 3, T. 37 N., R. 7 W., east along United States and Canada boundary to sec. 4, T. 37 N., R. 3 W.

T. 37 N., R. 7 W., in south side of foundation of monument 363; iron post	4,028.
T. 37 N., R. 7 W., northwest corner of sec. 1; point on section stone	3,999.

	Feet.
T. 37 N., R. 7 W., sec. 1, in south side of foundation of monument 362A; bronze tablet stamped "4024"	4,026.125
T. 37 N., R. 6 W., northwest corner of sec. 6, township corner; iron post stamped "4003"	4,005.913
T. 37 N., R. 6 W., in south side of foundation of monument 362; iron post stamped "4025"	4,028.130
T. 37 N., R. 6 W., northwest corner of sec. 4; top of section stone	4,193.39
T. 37 N., R. 6 W., in south side of foundation of monument 361; bronze tablet stamped "4407"	4,409.316
T. 37 N., R. 6 W., northwest corner of sec. 3; point on section stone	4,273.85
T. 37 N., R. 6 W., northwest corner of sec. 2; point on section stone	4,289.10
T. 37 N., R. 6 W., in south side of foundation of monument 360A; iron post stamped "4282"	4,284.525
T. 37 N., R. 6 W., 60 feet east of northwest corner of sec. 1; point on stone.	4,267.44
T. 37 N., R. 6 W., in south side of concrete foundation of monument 360; bronze tablet stamped "4282"	4,284.461
T. 37 N., R. 5 W., northwest corner of sec. 6; point on section stone	4,190.67
T. 37 N., R. 5 W., northwest corner of sec. 5; point on section stone	4,053.37
T. 37 N., R. 5 W., in south side of concrete foundation of monument 359A; iron post stamped "4069"	4,071.763
T. 37 N., R. 5 W., northwest corner of sec. 4; point on section stone	3,998.70
T. 37 N., R. 5 W., in south side of concrete foundation of monument 359; bronze tablet stamped "3963"	3,965.322
T. 37 N., R. 5 W., northwest corner of sec. 3; point on section stone	3,865.94
T. 37 N., R. 5 W., in south side of concrete foundation of monument 358A; iron post stamped "3899"	3,901.768
T. 37 N., R. 5 W., northwest corner of sec. 2; point on section stone	3,886.99
T. 37 N., R. 5 W., northwest corner of sec. 1; point on section stone	3,764.36
T. 37 N., R. 5 W., in south side of concrete foundation of monument 358; bronze tablet stamped "3763"	3,765.486
T. 37 N., R. 4 W., northwest corner of sec. 6; point on section stone	3,731.35
T. 37 N., R. 4 W., northwest corner of sec. 5; point on section stone	3,638.05
T. 37 N., R. 4 W., in south side of concrete foundation of monument 357B; iron post stamped "3634"	3,636.729
T. 37 N., R. 4 W., northwest corner of sec. 4; point on section stone	3,634.22
T. 37 N., R. 4 W., in south side of concrete foundation of monument 357A, iron post stamped "3663"	3,665.940
T. 37 N., R. 4 W., northwest corner of sec. 3; point on section stone	3,650.39
T. 37 N., R. 4 W., northwest corner of sec. 2; point on section stone	3,639.87
T. 37 N., R. 4 W., in south side of concrete foundation of monument 357, iron post stamped "3648"	3,651.002
T. 37 N., R. 4 W., northwest corner of sec. 1; point on section stone	3,600.32
T. 37 N., R. 4 W., in south side of concrete foundation of monument 356A, bronze tablet stamped "3587"	3,589.798
T. 37 N., R. 3 W., northwest corner of sec. 6; point on section stone	3,551.61
T. 37 N., R. 3 W., northwest corner of sec. 5; point on section stone	3,573.20
T. 37 N., R. 3 W., in south side of concrete foundation of monument 356; iron post stamped "3571"	3,573.745
T. 37 N., R. 3 W., northwest corner of sec. 4; point on section corner	3,536.06

DUPUYER QUADRANGLE.

Dupuyer southeast to Bynum.

Dupuyer, at southwest corner of crossing of principal street and street east-west past the Morton House, in rock set in ground; bronze tablet stamped "4121"	4,124.080

	Feet.
upuyer, 3 miles south of, top of hill, north side of valley, on east side of road; iron post stamped "4282"	4,284.560
upuyer, 5.75 miles south of, on top of ridge between two coulees; iron post stamped "4284"	4,287.209
ynum, 8.12 miles north of, top of small ridge on east side of road; iron post stamped "4566"	4,568.974
ynum, 6 miles north of, at mouth of coulee where road goes on top of butte just north of ranch; iron post stamped "4298"	4,301.530
ynum, 3 miles north of, on telegraph line; iron post stamped "4077"	4,080.029

rthwest to corner of sec. 3, T. 30 N., R. 7 W., east to northeast corner of sec. 1, T. 30 N., R. 6 W.

. 30 N., R. 7 W., northeast corner, in west side of small neck of large shallow lake, dry most of season; General Land Office iron post stamped "3786"	3,789.631
. 30 N., R. 6 W., 46 feet east of northwest corner of sec. 3, on rolling prairie; iron post stamped "3792"	3,795.570
. 30 N., R. 6 W., northeast corner of; General Land Office iron post stamped "3517"	3,520.788

c. 10, T. 31 N., R. 7 W., east 6 miles, thence southeast to southeast corner of sec. 13, T. 31 N., R. 6 W., thence south to southeast corner of sec. 36, T. 31 N., R. 6 W.

. 31 N., R. 6 W., northeast corner of sec. 9, in top of section stone; aluminum tablet stamped "3703"	3,706.565
. 31 N., R. 6 W., 800 feet N. 60° W. from southeast corner of sec. 13, 0.75 mile south of Two Medicine Creek, top of ridge, at top of rock 18 by 12 by 12 inches; aluminum tablet stamped "3733"	3,736.845

Southeast corner of sec. 13, T. 31 N., R. 6 W., north to northeast corner of sec. 1, T. 31 N., R. 6 W.

T. 31 N., R. 6 W., northeast corner of sec. 1, 2 miles north of Two Medicine Creek; General Land Office iron post stamped "3715"	3,718.449

GALATA QUADRANGLE.

Sec. 32, T. 31 N., R. 1 E., east along road down Marias River to sec. 11, T. 29 N., R. 5 E.,

T. 30 N., R. 2 E., southwest corner of sec. 16; top of corner stone	3,243.04
T. 30 N., R. 2 E., NE. ¼ SE. ¼ sec. 19, north side of Marias River, 1,000 feet northwest of sheep shed, 50 feet west of road, 0.5 mile north of Barney & Marsh ranch, at mouth of draw; iron post	3,001.003
T. 30 N., R. 2 E., sec. 24; nail in northwest corner post of Pier's stockyard	2,964.72
T. 30 N., R. 3 E., SW. ¼ SW. ¼ sec. 18, 150 feet northeast of Wood's ranch house at base of hill; iron post	2,967.050
Beatrice, NE. ¼ NW. ¼ sec. 24, T. 30 N., R. 3 E., southwest corner of J. C. Turner's yard, 50 feet from house; iron post	2,914.465
T. 30 N., R. 4 E., SE. ¼ SW. ¼ sec. 14, north of mouth of Willow Creek; 300 feet east of James Cockrill's ranch; iron post	2,887.087
T. 29 N., R. 5 E., SW. ¼ NW. ¼ sec. 11, 100 feet west of gate of Pugsley's ranch; iron post	2,831.120

GOODALE QUADRANGLE.

Augusta east to Great Falls (portion of line).[1]

Great Falls, 7 miles west of, at east foot of alkali hill, about 200 feet north of telephone line, opposite telephone pole 183; iron post	3,400.651

[1] This line is based upon adjusted elevation at Augusta, and is not adjusted on account of closure error of −5.727 feet upon corrected elevations at Great Falls

	Feet.
Great Falls, 4 miles west of, on telephone line, near telephone pole 82; iron post	3,324.416
Great Falls, 2 miles west of, about 700 feet north of coal chutes, at angle of telephone line, near telephone pole 26; iron post	3,339.421
Great Falls, on upstream end of pier; copper bolt leaded vertically in capstone; Missouri River Commission bench mark. (The adjusted elevation of this bench mark is 3,322.012, which is 3.915 feet greater than given by the Missouri River Commission)	3,316.285

HEART BUTTE QUADRANGLE.

Browning south along road to Fish Lake, thence southeast to point 9.3 miles west of Dupuyer.

Browning, 2.9 miles south of, N. ¼ sec. 35, T. 32 N., R. 11 W., on road to crossing of Two Medicine Creek about 2,000 feet south of small stream, on top of south grade of coulee; iron post stamped "4745"	4,748.451
T. 31 N., R. 11 W., SW. ¼ sec. 12, about 1 mile north of Two Medicine Creek, near top of ridge where canyon of Two Medicine Creek can be seen on road from Browning south across stream; iron post stamped "4715"	4,717.887
T. 31 N., R. 10 W., near center of sec. 31, on road from Browning to Upper Badger Valley between the Two Medicine Creek and Little Badger, on top of hill near small lake, on top of small rock; aluminum tablet stamped "4587"	4,590.290
Browning, 16.25 miles south of, on south bank of first canyon south of Little Badger Creek, about 5 miles east of foot of mountain and 800 feet east of sudden rise on south side of canyon, in bowlder 2 feet high; aluminum tablet stamped "4562"	4,564.280
T. 29 N., R. 10 W., northeast corner of sec. 5, in valley of Badger Creek on a tributary 1 mile south of main stream, 0.5 mile east of Bullhill's cabin, near a small lake, and west of two large lakes, in prominent bowlder; bronze tablet stamped "4511"	4,513.780
T. 29 N., R. 10 W., sec. 22, 9 miles north of Fish Lake, on highest ridge between South and North Fork of Whitetail River and on lowest point between Heart Butte and flat-topped butte east of Heart Butte, in small bowlder 8 inches above ground; aluminum tablet stamped "5037"	5,040.036
T. 28 N., R. 10 W., NE. ¼ NE. ¼ sec. 13, 2.85 miles north of Fish Lake, on north side of road leading from Griff Jones's place to Blackfeet Indian Reservation, near grove, 1,000 feet southwest of a small dry lake and about 0.5 mile north of Birch Creek, on bowlder; bronze tablet stamped "4895"	4.897.644
Fish Lake, 1,000 feet north of, 200 feet south of C. D. Punester's cabin, cemented vertically in large bowlder; bronze tablet stamped "4760"	4.762.896
Fish Lake, 4.5 miles southeast of, 0.25 mile northwest of Gordon's house, 1,200 feet south of Sheep Creek, on roadside, 30 feet north of fence, on top of large rock; aluminum tablet stamped "4780"	4,782.557
Fish Lake, 7.37 miles southeast of, 9.33 miles west of Dupuyer, at north end of lane between John Chase's and Timothy Connor's ranches; iron post stamped "4693"	4,696.019

Raymond north 10 miles, thence east to Dupuyer.

Raymond, about 45 feet in front of J. L. Collins's house; iron post stamped "4671"	4,674.034
Raymond, 5 miles north of, 50 feet south of Adolph Aman's ranch house; iron post stamped "4869"	4,872.150

	Feet.
Raymond, 8 miles north of, on east line of Lewis and Clark National Forest, T. 27 N., R. 8 W.; iron post stamped "4779"	4,781.896
Dupuyer, 7.87 miles west of, top of knoll 300 feet east of small graveyard north of road about 0.12 mile from Seloway's ranch; iron post stamped "4523"	4,526.030
Dupuyer, 3.37 miles west of, north side of road at south end of lane between Dennis and Leach ranches; iron post stamped "4285"	4,287.975

NE. ¼ sec. 13, T. 28 N., R. 10 W., northeast to east boundary of R. 9 W. in T. 29 N., thence to northeast corner of T. 29 N., R. 9 W., thence southwest to sec. 22, T. 29 N., R. 10 W.

T. 28 N., R. 9 W., NW. ¼ sec. 4, 1 mile west of gate leading to Geo. Schultz's place, on hillside 8 feet south of road, in large flint rock with flat sloping top; aluminum tablet stamped "4677"	4,680.448
T. 29 N., R. 9 W., 500 feet north of southeast corner of sec. 24, 2.3 miles east of gate leading to Geo. Schultz's place, 300 feet west of corner of residence fence, 2 feet north of reservation fence; iron post stamped "4414"	4,417.283
T. 29 N., R. 9 W., sec. 1, Sita triangulation station, top of highest point between Whitetail and Blacktail Creeks, 0.25 mile west of range line of ranges 8 and 9 W.; iron post stamped "4790.6"	4,794.084
T. 29 N., R. 9 W., northeast corner of, 500 feet west of road, 1 mile northeast of Sita triangulation station; iron post stamped "4320"	4,323.646
T. 29 N., R. 9 W., 0.25 mile southwest of northeast corner of sec. 5, 8 feet south of road from Piegan to Heart Butte, on southeast side of Whitetail Creek, 0.5 mile east of road forks and creek crossing, on knoll; iron post stamped "4430"	4,433.306

Bench mark in T. 29 N., R. 10 W.

T. 29 N., R. 10 W., northeast corner of; iron post stamped "4445"	4,448.649

Northeast corner of T. 29 N., R. 9 W., north 6 miles, thence west to northeast corner of T. 30 N., R. 11 W.

T. 30 N., R. 9 W., 400 feet southeast of northeast corner of sec. 12, at top of long rocky ridge 1,000 feet west of road, 1.5 miles north of lake, in large rock; aluminum tablet stamped "4202"	4,205.171
T. 30 N., R. 9 W., northeast corner of, on south side of valley of Badger Creek, west of road from Piegan to lake; iron post stamped "4098"	4,101.740
T. 30 N., R. 10 W., 132 feet east of northwest corner of sec. 3, 0.5 mile northwest of Badger, 200 feet north of road, at first position of reestablished corner; iron post stamped "4112"	4,115.431
T. 30 N., R. 10 W., northeast corner of, top of high ridge between Big and Little Badger creeks; General Land Office iron post stamped "4461"	4,464.382
T. 30 N., R. 10 W., northeast corner of sec. 4, 11 miles west of Piegan, top of small bowlder 12 by 6 inches; aluminum tablet stamped "4678" marked by large monument	4,681.459
T. 30 N., R. 11 W., northeast corner of; General Land Office iron post stamped "4519"	4,522.964

Northeast corner of T. 29 N., R. 9 W., east 6 miles, thence north 6 miles, thence east 3 miles to northwest corner of sec. 3, T. 30 N., R. 7 W.

T. 29 N., R. 8 W., 5 feet from section stone at northeast corner of sec. 4, 300 feet south of Blacktail Creek, on slope 500 feet west of pointed clay hill; iron post stamped "3990"	3,993.344

T. 30 N., R. 8 W., 800 feet north of quarter corner on east side of sec. 24, 200 feet south of Blacktail Creek, on large rocky ledge, west end of rocky cut bank facing creek, 800 feet west of road crossing of creek, in sandstone bowlder 3 by 2 by 1.5 feet; aluminum tablet stamped "3909"..... Feet. 3,912.480

T. 30 N., R. 8 W., northeast corner of, 0.75 mile southwest of Twin Buttes, 300 feet north of dry creek, on small knoll; General Land Office iron post stamped "4056"..... 4,059.885

T. 30 N., R. 7 W., 390 feet east of northwest corner of sec. 3, on west slope of small knoll, 6 feet north of township line, in red granite rock 20 by 8 inches, 6 inches out of ground, marked by mound; aluminum tablet stamped "3923"..... 3,926.795

Northeast corner of T. 30 N., R. 9 W., northeast to sec. 1, T. 31 N., R. 8 W., thence southeast to sec. 10, T. 31 N., R. 7 W.

Piegan, sec. 18, T. 31 N., R. 8 W., 10 feet north of south gate, 4 feet west of stockade; iron post stamped "3897"..... 3,900.458

Piegan, 4.8 miles east of, north line of sec. 11, T. 31 N., R. 8 W., north side of Rocky Bluff, 25 feet above road and 100 feet south of it, 130 feet south of creek; iron post stamped "3816"..... 3,819.427

T. 31 N., R. 8 W., 1,500 feet southwest of northeast corner of sec. 1, 700 feet southeast of forks of Badger and Two Medicine Rivers, 800 feet north of Steve Eneault's log cabin, northeast corner of corral; iron post stamped "3723"..... 3,726.422

T. 31 N., R. 7 W., near southwest corner of sec. 10, 1 mile east of Mott's ranch, west end of cut bank, north side of small knoll, 40 feet above and 240 feet south of Two Medicine River, on creek bank near road, in top of stone 4 feet by 2 feet and 4 inches above ground; aluminum tablet stamped "3690;" location marked by reference monument with base 2 feet higher than tablet..... 3,693.289

HOGAN QUADRANGLE.

Point near Landers Fork northeast over Lewis and Clark Pass to Stearns.

Patterson's ranch, 1.3 miles west of, north side of Indian trail in park, 50 feet east of timber, in stone 2 feet by 2 feet and 12 inches above ground; aluminum tablet stamped "5634 BUTTE"..... 5,636.136

Patterson's ranch, at southwest corner of yard fence; iron post stamped "5328 BUTTE"..... 5,330.339

Patterson's ranch, 3.7 miles north of, west side of trail on small open ridge at mouth of ravine from west; iron post stamped "5461 BUTTE"..... 5,463.424

Lewis and Clark Pass, Continental Divide; ground elevation..... 6,422.

Lewis and Clark Pass over Continental Divide, 900 feet southeast of point where trail crosses summit, 200 feet south of pack trail, 300 feet east of wagon trail, mound of rock on sandstone ledge; bronze tablet stamped "6380 BUTTE"..... 6,382.479

Lewis and Clark Pass, 2.7 miles east of summit of, 200 feet north of fork of Green Creek, north side of road; iron post stamped "4778 BUTTE"..... 4,780.225

Steinbach's ranch, 1.5 miles southwest of, on small ridge near east road fence; iron post stamped "4925 BUTTE"..... 4,927.421

Steinbach's ranch, 2 miles southeast of, in corner of fence near point where road leaves ridge; iron post stamped "4492 BUTTE"..... 4,494.290

Stearns (Borho's ranch), 20 feet east of post office, inside garden fence; iron post stamped "4124 BUTTE"..... 4,126.675

Stearns east along highway to Craig.

	Feet.
Stearns, 5.7 miles east of, about 0.7 mile north of Wolf Creek, on county road, west side of south fork of Dearborn River, 150 feet south of Renig Bros.' ranch, at corner of fence; iron post stamped "4096 BUTTE"	4,098.931
Fulton, 3 miles north of, on reef of rocks where road turns west to Big Flats; aluminum tablet stamped "4221 BUTTE"	4,223.897
Craig, 9.7 miles northwest of, east side of road, at turn toward Stearns post office, at gate entrance to Gillette's ranch; iron post stamped "3984 BUTTE"	3,987.218
Craig, 6.5 miles northwest of, 1 mile east of telephone line, north side of road at corner of pasture; iron post stamped "4138 BUTTE"	4,140.871
Craig, 3.7 miles west of, right side of road, foot of grade, corner of fence to pasture; iron post stamped "3728 BUTTE"	3,730.909
Craig, 700 feet north of station, crossroads, at point where road turns west to Augusta, on south side of road opposite schoolhouse; iron post stamped "3454 BUTTE"	3,457.104
Craig, about 125 feet southeast of station, on west bank of Missouri River; Missouri River Commission bench mark No. 29:	
Top of cap of iron post	3,457.515
Subsurface mark	3,453.484
(The elevations by Missouri River Commission are 3,453.634 and 3,449.603, respectively.)	

Stearns north along Wolf Creek-Augusta road via Clemens to Augusta.

Stearns, 40 feet in front of house, in garden; iron post stamped "412a BUTTE"	4,126.675
Stearns, 3.8 miles west of, south side of road, at entrance to Bennett's ranch; iron post stamped "4447 BUTTE"	4,449.638
Clemens, 3.3 miles southeast of, west side of North Fork of Dearborn Canyon, top of grade; iron post stamped "4727 BUTTE"	4,730.245
Clemens; iron post stamped "4673 BUTTE"	4,676.239
Clemens, 2 miles northwest of, west side of road, top of first flat near Mike Connor's ranch; iron post	4,588.803
Augusta, 8 miles southeast of, east end of Hog Back Butte, on east side of road at angle of fence; iron post stamped "4361 BUTTE"	4,363.370
Augusta, 4.84 miles south of, at point where road turns east over hill; iron bench mark post stamped "4268 BUTTE"	4,271.014
Augusta, 1.84 miles south of, about 0.8 mile southwest of Craig-Augusta stage line, west side of road; iron post stamped "4121 BUTTE"	4,124.153
Augusta, 0.5 mile south of, bridge across South Fork of Sun River; nail in southwest corner post	4,093.15
Augusta, northeast corner of livery barn; iron post stamped "4064 BUTTE"	4,067.323

Augusta northwest 6 miles.

Augusta, 6.1 miles northwest of, south side of road, opposite Herbert Sherman's residence, at gate to field; iron post stamped "4274 BUTTE"	4,276.691

Augusta east to Great Falls (portion of line).[1]

Augusta, 3.1 miles northeast of, on Augusta-Great Falls road, in front of Philip Mayer's residence; iron post	3,968.736

[1] This line is based upon adjusted elevation at Augusta; the first 6 miles is checked by Reclamation Service levels, but the remainder is unadjusted on account of a closure error of —5.727 feet on corrected elevation at Great Falls.

	Feet.
Augusta, 6 miles northeast of, on south side of Augusta-Great Falls road, just east of creek; iron post	3,886.913
Rhoner, near gate entrance to Lang's residence, Augusta-Great Falls road; iron post	3,824.749
Rhoner; at entrance to John Rhoner's residence, near schoolhouse; iron post	3,769.174
Hefler, 6 miles west of, on north side of Augusta-Great Falls road, at mouth of Gulch; iron post	3,716.524
Hefler, 2 miles west of, on south side of Augusta-Great Falls road, about opposite Flume's home ranch, corner of field; iron post	3,691.197

SAYPO QUADRANGLE.

Point 6 miles northwest of Augusta north along highway to Saypo, thence east to Belleview.

Augusta, 9 miles northwest of, north end of fenced portions of road at angle; iron post stamped "4328 BUTTE"	4,331.029
Augusta, 12.2 miles northwest of, northwest end of valley, 1,000 feet west of culvert, at angle of road; iron post stamped "4317 BUTTE"	4,320.170
Augusta, 15.5 miles northwest of, on coal mine road, 2,000 feet north of branch of canyon road, just east of lake at mouth of Coulee; iron post stamped "4337 BUTTE"	4,340.145
Augusta, 18 miles northwest of, north side of North Fork of Sun River, north side of road, 1,500 feet from coal mine, at point where road cuts through sandstone reef; bronze tablet stamped "4343 BUTTE"	4,345.999
Elizabeth, 2.33 miles south of, at point where road branches off toward Choteau, at gate of Caldwell's ranch; iron post stamped "4840 BUTTE"	4,843.424
Elizabeth, southeast corner of wagon shed; iron post stamped "4806 BUTTE"	4,809.052
Saypo, 6.5 miles south of, top of grade at crossing of Deep Creek, on Saypo-Elizabeth mail route; iron post stamped "4855 BUTTE"	4,858.968
Saypo, 3 miles southwest of, 65 feet in front of Robert Twig's residence; iron post stamped "4812 BUTTE"	4,815.010
Saypo, southeast corner of dwelling; iron post stamped "4646 BUTTE"	4,648.892
Saypo, 2.6 miles east of, at gate of D. C. Craig's ranch; iron post stamped "4473 BUTTE"	4,476.136

Saypo north along wagon road to Raymond.

Saypo, 3 miles north of, at gate entrance to Fisher's residence; iron post stamped "4622 BUTTE"	4,625.481
Saypo, 6.75 miles north of, on north bank of Teton River, about 1 mile east of Teton River forks, at point where road goes down from flat into valley of river; iron post stamped "4836 BUTTE"	4,839.098
Saypo, 9.2 miles north of, at gap in east and west ridge, south end of open prairie; iron post stamped "4831 BUTTE"	4,833.829
Raymond, 4.25 miles south of, at north gate to Clark Bros. upper ranch, about 2.5 miles west of Clark's home ranch; iron post stamped "4649 BUTTE"	4,652.008

Sun River project, north side diversion line.[1]

T. 22 N., R. 9 W., near southeast corner (unsurveyed) 3,300 feet west of east boundary of forest reserve, on north side of river, in rock cliff half way between wall and water; aluminum tablet stamped "BUTTE 4489"	4,491.892

[1] A correction of 3.1 feet has been added to the Reclamation Service values.

	Feet.
T. 22 N., R. 8 W., 700 feet east of west quarter corner of sec. 31; iron post stamped "BUTTE 4448"	4,450.970
T. 22 N., R. 8 W., 625 feet east and 175 feet south of corner of secs. 29, 30, 31, and 32; iron post stamped "BUTTE 4440"	4,442.994
T. 22 N., R. 8 W., 660 feet west and 300 feet south of corner of secs. 20, 21, 28, and 29; iron post stamped "BUTTE 4442"	4,445.416
T. 22 N., R. 8 W., 1,275 feet west of southeast corner of sec. 16; iron post stamped "BUTTE 4449"	4,451.711
T. 22 N., R. 8 W., 600 feet north of west quarter corner of sec. 23; iron post stamped "BUTTE 4456"	4,458.610
T. 22 N., R. 8 W., 1,800 feet east and 250 feet south of west quarter corner of sec. 13; iron post stamped "BUTTE 4447"	4,450.319
T. 22 N., R. 8 W., 1,490 feet west and 78 feet north of east quarter corner of sec. 13; iron post stamped "BUTTE 4379"	4,382.257
T. 22 N., R. 7 W., corner of secs. 7, 8, 17, and 18; iron post stamped "BUTTE 4401"	4,404.019
T. 22 N., R. 7 W., 1,320 feet north of east quarter corner of sec. 8; iron post stamped "BUTTE 4387"	4,390.464

SWEETGRASS QUADRANGLE.

Point near Coutts south along highway and branch of Great Northern Ry. to Shelby.

Coutts, 3 miles south of, 20 feet west of Coutts-Shelby road, 0.7 mile northeast of ranch, 0.5 mile west of Great Northern Railway; iron post stamped "3405 GN"	3,415.585
Milepost 130, seventh telegraph pole north of; spike	3,379.78
Milepost 121; spike	3,346.07
T. 33 N., R. 3 W., northwest corner of sec. 1, 1.5 miles east of Great Northern Railway; corner stone	3,325.10
Shelby, H. L. Guth's store, northeast corner of foundation of cellar; bronze tablet stamped "3285 GN"	3,296.326

Sec. 4, T. 37 N., R. 3 W., east along United States and Canadian boundary to Coutts, thence south 3 miles.

T. 37 N., R. 3 W., Canadian section corner; point on rock at foot of corner post	3,493.02
T. 37 N., R. 3 W., in south side of concrete foundation of monument 355A; bronze tablet stamped "3495"	3,498.069
T. 37 N., R. 3 W., northwest corner of sec. 2; point on section stone	3,554.42
T. 37 N., R. 3 W., 4 feet north of monument 355; point on concrete	3,553.52
T. 37 N., R. 3 W., 80 feet east of track, in south side of concrete foundation of monument 354B; iron post stamped "3466"	3,469.546
United States and Canada boundary, at station; top of rail	3,471.00
Sweetgrass, 1.2 miles south of, southeast end of culvert on Great Northern Railway; bolt 1 foot from top	3,442.23

Browning, Chief Mountain, Kalispel, Kintla Lakes, Midvale, Nyack, and Ural Quadrangles.

FLATHEAD AND TETON COUNTIES.

The elevations in the following list were determined by primary leveling forming part of a net extending from Butte to the United States and Canada boundary. They accord with preliminary values

in the vicinity of Butte, computed in 1911 for the Coast and Geodetic Survey precise level line. Orthometric corrections have been applied.

The leveling was done in the Browning quadrangle in 1900 and 1901 by Goyne Drummond and by the Reclamation Service, and in 1909 and 1910 by the United States and Canada Boundary Survey; in the Chief Mountain quadrangle in 1900 by Goyne Drummond, and in 1901 by J. T. Stewart; in the Kalispel quadrangle in 1901 by J. T. Stewart, and in 1904 by G. H. Kendall; in the Kintla Lakes quadrangle in 1901 by J. T. Stewart, and in 1903 by A. E. Franklin and the United States and Canada Boundary Survey; in the Midvale quadrangle in 1900 by Goyne Drummond, and in 1901 by J. T. Stewart; in the Nyack quadrangle in 1901 by J. T. Stewart, and in 1907 by C. H. Hartmann; and in the Ural quadrangle in 1903 by A. E. Franklin and the United States and Canada Boundary Survey.

BROWNING QUADRANGLE.

Browning northwest along road via Wetzel ranch to Main.

	Feet.
Browning, sec. 3, T. 32 N., R. 11 W., 6 feet south of hospital; iron post stamped "4366 GN"	4,375.759
T. 33 N., R. 11 W., NW. ¼ sec. 15, 0.25 mile north of Cutbank Creek, 20 feet east of road; iron post stamped "4457 GN"	4,467.438
T. 34 N., R. 12 W., near quarter corner on south side of sec. 12, on divide between Greasewood Creek and South Fork of Milk River, 0.7 mile northwest of triangulation station; iron post stamped "5007 GN"	5,017.244
T. 34 N., R. 11 W., sec. 18, Cutbank triangulation station, 0.5 mile east of road, 16 miles from Blackfoot, 12.8 miles from Browning; aluminum plug unmarked (on side line; not checked)	5,106.363
T. 35 N., R. 12 W., NW. ¼ sec. 34, 150 feet southeast of Wetzel's house, near fence; iron post stamped "4739 GN"	4,748.638
T. 36 N., R. 12 W., sec. 19, 1.2 miles north of Middle Fork of Milk River, in fork of road, on divide; iron post stamped "4893 GN"	4,902.873
Duck Lake; surface of water	5,021
T. 36 N., R. 13 W., near northwest corner of sec. 22, 200 feet south of Duck Lake, 0.4 mile from east end of lake, 60 feet south of road; iron post stamped "5049 GN"	5,058.666
T. 36 N., R. 13 W., S. ½ sec. 19, 120 feet south of house; iron post stamped "5036 GN"	5,046.410
Main, 600 feet southeast of, sec. 15, T. 36 N., R. 14 W., 20 feet south of road, on bench; iron post stamped "4461 GN"	4,471.223

Main south along road to Upper St. Marys Lake.

T. 36 N., R. 14 W., near south line of sec. 27, 2.2 miles south of Main, 30 feet east of lower (north) end of Lower St. Marys Lake, 300 feet south of ford, 10 feet west of road; iron post stamped "4477 GN"	4,487.298
T. 35 N., R. 14 W., sec. 33, 60 feet east of Upper St. Marys Lake and 800 feet southeast of outlet; iron post stamped "4478 GN" (on side line; not checked)	4,488.351
Upper St. Marys Lake; surface of water, July 17, 1900	4,483

Point near Main southeast across country to Two Medicine Lake.

	Feet
T. 35 N., R. 14 W., near east line of sec. 12, 0.25 mile west of divide, 60 feet south of road, by flag station mound; iron post stamped "5784 GN"	5,792.
T. 35 N., R. 13 W., near quarter corner on east side of sec. 28, on divide between Livermore Creek and Middle Fork of Milk River, about 0.5 mile west of point where Browns road crosses divide, 20 feet north of road running west; iron post stamped "5324 GN"	5,332.
T. 34 N., R. 13 W., S. ½ sec. 10, at pass on top of divide between Fox and Livermore Creeks, about 0.5 mile north of Little Creek; iron post stamped "5244 GN"	5,252.
T. 34 N., R. 13 W., SW. ¼ sec. 27, on edge of bench land, on South Fork of Milk River, 500 feet north of creek; iron post stamped "5229 GN"	5,237.
T. 33 N., R. 13 W., sec. 9, near east line, on top of divide between North Fork of Cutbank Creek and South Fork of Milk River; iron post stamped "5554"	5,562.
T. 33 N., R. 13 W., NW. ¼ sec. 26, on top of divide between North Fork and South Fork of Cutbank Creek; iron post stamped "5395 GN"	5,403.
T. 32 N., R. 13 W., near southwest corner of sec. 1, 170 feet east of Henry Merchants house, 50 feet south of South Fork of Cutbank Creek; iron post stamped "4927 GN"	4,935.
T. 32 N., R. 13 W., NW. ¼ sec. 25, 2 miles east of Two Medicine Lake, 20 feet south of road, near divide; iron post stamped "5651 GN"	5,659.

Browning northwest to sec. 27, T. 34 N., R. 13 W., on South Fork of Milk River.

T. 33 N., R. 12 W., SW. ¼ sec. 25, 2 miles east of "Shorty Whitegrass" house, 500 feet south of Cutbank Creek, top of bluff, east angle of forks of road; iron post stamped "4644 GN"	4,654.
T. 33 N., R. 12 W., N. ½ sec. 4, 3 miles north of Cutbank Creek; 100 feet south of three cabins on Upper Greasewood Creek; iron post stamped "4941 GN"	4,950.

Main southwest up Swift Current Creek to crossing.

T. 36 N., R. 14 W., near north line of sec. 32, 2.7 miles west of Main 60 feet north of Swift Current Creek crossing, 30 feet north of road; iron post stamped "4633 GN"	4,643.

Browning southwest across prairie to Durham.

Browning, 2.4 miles southwest of, 0.5 mile north of track, 5 feet north of new grade, in telegraph pole marked "4487.07;" spike. (Great Northern Railway bench mark)	4,497.
Durham, in front of station; top of rail	4,552.

Browning agency south along road via Browning station to Durham triangulation station.

Browning, in front of station; top of rail	4,467.
Browning, 60 feet west of station, 30 feet north of track; iron post stamped "4458 GN"	4,468.
Durham, 0.75 mile south of, Durham triangulation station, near south line, sec. 21, T. 32 N., R. 11 W., on high point of ridge, in rock; copper plug stamped "4879 GN"	4,889.

Greasewood Creek north along road via Bird's ranch to top of divide between north and south forks of Milk River.

	Feet.
T. 34 N., R. 11 W., sec. 28, 500 feet south of road crossing of North Fork of Greasewood Creek, 50 feet east of forks of road; iron post stamped "4344 GN"	4,353.988
T. 35 N., R. 11 W., SW. ¼ sec. 33, top of divide betewen Greasewood Creek and South Fork of Milk River, 50 feet west of forks of road; iron post stamped "4788 GN"	4,897.075
T. 35 N., R. 11 W., sec. 20, 3 miles south of Bird's ranch, top of spur, 50 feet west of road; iron post stamped "4761 GN"	4,770.931
T. 35 N., R. 11 W., near center of sec. 8, in yard at southeast corner of Bird's ranch, 50 feet southeast of house; iron post stamped "4546 GN"	4,556.037
T. 36 N., R. 11 W., sec. 27, 250 feet south of Middle Fork of Milk River, 60 feet west of road; iron post stamped "4424 GN"	4,433.964
T. 36 N., R. 11 W., near west side of sec. 10, 3 miles north of Middle Fork of Milk River, top of ridge between two small creeks, 120 feet west of road; iron post stamped "4612 GN"	4,621.893
T. 37 N., R. 11 W., SW. ¼ sec. 35, top of divide between North Fork and South Fork of Milk River, 50 feet west of road; iron post stamped "4672 GN"	4,681.955

Main northeast along road and canal to Spider Lake, thence east to Halls ranch, northeast to Emigrant Gap, and southeast to junction of North Fork and South Fork of Milk River (Reclamation Service bench marks).

T. 37 N., R. 14 W., sec. 36, 0.4 mile northeast of Powell's ranch and 0.4 mile east of ford; iron post stamped "4467 GN"	4,477.077
T. 37 N., R. 13 W., sec. 30, 5.7 miles northeast of Main, 1 mile west of Spider Lake, 20 feet north of road; iron post stamped "4473 GN"	4,482.981
Spider Lake; surface of water	4,447
T. 37 N., R. 13 W., near northwest corner of sec. 23, 1 mile east of Spider Lake, on bluff on south side of ravine, about 800 feet south of road; iron post stamped "4462 GN"	4,472.666
T. 37 N., R. 12 W., sec. 19, 1.5 miles southwest of Galbreath's ranch, 100 feet east of road; iron post stamped "4493 GN"	4,503.569
T. 37 N., R. 13 W., near south side of sec. 25, Galbreath triangulation station, on Galbreath's ranch, on east end of ridge dividing Galbreath's Basin from North Fork of Milk River, 0.5 mile west of low divide, in stone 2 feet in ground; aluminum bolt stamped "5196 GN" (on side line; not checked)	5,206.486
T. 37 N., R. 12 W., sec. 32, Hall's ranch, 15 feet south of house, in yard; iron post stamped "4565 GN" (on side line; not checked)	4,575.469
T. 37 N., R. 12 W., sec. 21, 2 miles east of Galbreath's ranch, 2 miles east of ridge, 2 miles south of lake; iron post stamped "4452 GN"	4,462.488
Emigrant Gap, NW. ¼ sec. 8, T. 37 N., R. 11 W., 60 feet east of road; iron post stamped "4473 GN"	4,483.247
T. 37 N., R. 11 W., NE. ¼ sec. 21, 0.7 mile south of North Fork of Milk River, 30 feet east of McLeod road; iron post stamped "4436 GN"	4,446.557

The following elevations in the Browning quadrangle were determined by the United States and Canada boundary survey:

Point 3.5 miles southeast of Galbreath's ranch west and north to Canadian boundary, thence east and southwest to Emigrant Gap.

	Feet.
Monument 373, United States and Canada Boundary Survey; tablet	4,680.195
Monument 372, United States and Canada Boundary Survey; tablet	4,221.787

	Feet.
Monument 372, 500 feet east of, top of section corner; post	4,203.3
T. 37 N., Rs. 11 and 12 W.; iron section post	4,290.3
Monument 371, 10 feet west of; iron post	4,630.4

Galbreath's ranch north to Canadian boundary, thence west to Pike Lake, thence southeast to sec. 36, T. 37 N., R. 14 W.

T. 37 N., Rs. 12 and 13 W., at public land corner, on line 0.5 mile west of monument 373; iron post	4,431.1
Monument 374; iron post	4,411.1
T. 37 N., R. 13 W., northwest corner of sec. 2; point on section stone	4,314.0
Monument 375, 45 feet west of, on line, in solid rock; tablet stamped "4430"	4,432.0
Monument 376, 10 feet west of; iron post	4,723.6
Monument 377; tablet	4,616.9
Pike Lake; surface of water, July 9, 1909	4,530.3
Smith's ranch house, 0.5 mile northeast of, 60 feet from old road on uphill side, 0.3 mile east of small lake; iron post stamped "U. S. & C. B. Survey"	4,570.9
Main, 3.5 miles northeast of, 0.4 mile northeast of Powell's ranch, 0.4 mile east of ford; iron post stamped "4467 GN"	4,477.0

Monument 371 east to sec. 2, T. 37 N., R. 11 W.

Monument 371, 10 feet west of; iron post	4,630.4
T. 37 N., R. 11 W., northwest corner of sec. 3; point on section stone	4,472.5
T. 37 N., R. 11 W., north side of sec. 3, in south side of foundation of monument 370A; bronze tablet	4,417.8
T. 37 N., R. 11 W., northwest corner of sec. 2; point on top of section stone	4,342.9

CHIEF MOUNTAIN QUADRANGLE.

Swift Current Creek crossing west to Swift Current Pass (leveled twice).

Lower Sherburne Lake, narrows, 50 feet north of water edge, 15 feet south of road; iron post stamped "4741 GN"	4,750.9
Upper Sherburne Lake; surface of water	4,736
Upper Sherburne Lake, 500 feet northeast of, on spur 40 feet south of road, 60 feet east of Little Creek; iron post stamped "4776 GN"	4,786.0
Altyn, 30 feet east of Harris's house; iron post stamped "4774 GN" (on side line; not checked)	4,784.6
Bullhead cabin, 300 feet west of, in rim rock; bronze tablet stamped "5068 GN"	5,078.6
Lake south of Bullhead cabin; surface of water	5,042
Swift Current Pass, at foot on east side, 3 feet west of trail, 50 feet west of creek, in south end of rim rock; bronze tablet stamped "5278 GN"	5,288.7

Belton northwest to Apgars, thence northeast along road to Swift Current Pass.

Belton, in front of station; top of rail	3,213.7
Belton, 10 feet southwest of post office; iron post stamped "3200 GN"	3,210.2
Apgars, lower end of McDonald Lake, 100 feet south of steamboat landing, 30 feet east of east log house at Apgar's Hotel, 20 feet west of road; iron post stamped "3154 GN"	3,163.5
McDonald Lake; surface of water, July 9, 1901	3,154
Glacier Hotel, 40 feet northwest of, 150 feet northeast of steamboat landing; iron post stamped "3167 GN"	3,177.0

Glacier Hotel, 3.4 miles northeast of, 20 feet east of trail, 2 feet above ground, in vertical face of limestone rock 10 feet wide by 10 feet high; bronze tablet stamped "3346 GN" ..... Feet. 3,355.420

Glacier Hotel, 6 miles north of, 125 feet east of waterfall in McDonald Creek, east side of trail, a red rock 4 by 6 feet and 30 inches high; bronze tablet stamped "3436 GN" 3,445.274

Glacier Hotel, 9 miles northeast of, north side of small slide, west side of trail, rock 4 by 6 feet and 15 inches high; bronze tablet stamped "3523 GN" 3,533.465

Glacier Hotel, 12.2 miles northeast of, highest point on big slide crossed by trail, east side of trail, granite rock 2 by 4 feet by 20 inches high; bronze tablet stamped "3732 GN" 3,742.480

McDonald Creek, at foot of Swift Current Pass; surface of water 3,804.2

Glacier Hotel, 15 miles northeast of, 40 feet east of forks of trail, at foot of ascent to Swift Current Pass from west, in limestone ledge at surface of ground; bronze tablet stamped "3859 GN" 3,869.488

Swift Current Pass, top of Continental Divide, south side of trail, in limestone outcrop; bronze tablet stamped "7176 GN" 7,185.851

Swift Current Pass south 0.4 mile (single spur line).

Swift Current Pass, 0.4 mile south of summit, south end of rocky ridge, 470 feet higher than pass; bronze tablet stamped "7647 GN" 7,656.749

KALISPEL QUADRANGLE.

Belton along Great Northern Ry. to Columbia Falls (double run line).

Belton, 3.5 miles southwest of, near northeast end of Lake Five, in rock cut on north side of track and level with rail; aluminum tablet stamped "3262 GN" 3,271.568

Coram, south end of east abutment of railroad bridge over Flathead River, top of abutment level with bridge seat; aluminum tablet stamped "3127 GN" 3,136.734

Coram, 3 miles southwest of, 500 feet west of tunnel 5, 2 feet higher than rail at foot of cliff, north of track; aluminum tablet stamped "3109 GN". 3,119.276

Columbia Falls, 60 feet north of center of station; iron post stamped "3097 GN" 3,107.085

Columbia Falls southwest along Kalispel branch, Great Northern Ry., to Somers (double-run line).

Daly's spur, opposite signboard, 3 miles southwest of Columbia Falls, at C. E. Burgoyne's place, on west slope of hill through which railroad cuts, middle of first curve at east end of long tangent, 50 feet south of track, opposite mileboard 1214, 5 feet south of fence; iron post stamped "3016 GN" 3,026.624

La Salle, 500 feet southwest of section house, 1,000 feet southwest of Kalispel North Base triangulation station, 50 feet west of milepost 1217, 40 feet north of railroad track, 1,200 feet northeast of Amos Root's place, 40 feet east of wagon road; iron post stamped "2963 GN" 2,973.624

La Salle, Kalispel North Base triangulation station, 500 feet northeast of section house, 35 feet east of east rail of Great Northern Ry.; iron post set in cement (three other posts are set as reference marks 10 feet east, 20 feet north, and 15 feet west) 2,971.109

La Salle, 1.2 miles southwest of, 40 feet northwest of milepost 1220, 70 feet north of railroad track, 700 feet west of small house, 200 feet northwest of large barn and houses, 20 feet south of wagon road, 50 feet southwest of 18-inch fir; iron post stamped "2932 GN" 2,942.663

Kalispel, 4.5 miles northeast of, Kalispel South Base triangulation station, 35 feet east of east rail Great Northern Ry.; iron post set in cement (three other posts are set as reference marks 10 feet east, 20 feet south, and 12 feet west)..... Fee 2,92

Kalispel, 2.2 miles northeast of, near B. & M. Lumber Co.'s spur No. 1, 100 feet south of railroad track, at end of wagon road, 150 feet southwest of headblock of switch, 3 feet northeast of 2-foot fir tree; iron post stamped "2908 GN"..... 2,91

Kalispel, 100 feet east of station, at southeast corner of building, 5 feet west of walk; iron post stamped "2945 GN"..... 2,95

Kalispel, 3 miles south of, 50 feet east of track at Joe Gauger's slaughter-house, 10 feet west of water tank, just outside right of way fence, 1,500 feet south of road crossing; iron post stamped "2924 GN"..... 2,93

Kalispel, 6 miles south of, in southwest corner of Mitton's barnyard, east side of track, 300 feet from barn, 5 feet from gate; iron post stamped "2905 GN"..... 2,915

Somers, 200 feet east of planing mill, 150 feet east of railroad track, near switch to sawmill, 15 feet east of road; iron post stamped "2900 GN"... 2,910

Flathead Lake; surface of water, August 17, 1904..... 2,884

KINTLA LAKES QUADRANGLE.

Apgars, at lower end of McDonald Lake, northwest along wagon road to North Fork of Flathead River at mouth of Logging Creek, thence up river to international boundary line (mean of two lines).

McGee's meadow, north side of, 30 feet east of abandoned cabin, 30 feet west of road; aluminum tablet stamped "3855 GN"..... 3,864.

Camas Creek, 300 feet north of, 75 feet northwest of road fork to Christensen ranch, 20 feet east of road; aluminum tablet stamped "3779 GN"..... 3,788.

Dutch Creek, 0.2 miles northwest of crossing of, in small bowlder 75 feet east of road, on side hill; aluminum tablet stamped "3707 GN"..... 3,716.

Anaconda Creek, 0.6 mile northwest of crossing of, 15 feet north of road, west side of small park; aluminum tablet stamped "3585 GN"..... 3,594.

Logging Creek, 0.4 mile northwest of crossing of, in small bowlder 20 feet east of road; aluminum tablet stamped "3443 GN"..... 3,453.

Quartz Creek, 0.7 mile northwest of crossing of, in small bowlder 20 feet east of road; aluminum tablet stamped "3489 GN"..... 3,499.

Bowman Creek, 1.3 miles southwest of crossing of, in large bowlder on east side of road; aluminum tablet stamped "3692 GN"..... 3,701.

Herrick's cabin, 0.6 mile north of, in small bowlder on west side of road; aluminum tablet stamped "3578 GN"..... 3,587.

Round Prairie, near northeast side of, 700 feet southwest of point where road starts up hill, east side of old trail, in rock; aluminum tablet stamped "3681 GN"..... 3,690.

Kintla Oil Co. well, 0.2 mile east of, 10 feet north of road; iron post stamped "3800"..... 3,810.

Kintla Creek, 0.2 mile north of mouth of, 150 feet northwest of bridge; iron post stamped "3841"..... 3,851.

Starvation Creek, 60 feet southeast of mouth of; iron post stamped "3835".. 3,845.

Kishenehn trail and Flathead trail, 10 feet north of junction; iron post stamped "3886"..... 3,896.

International Boundary Line, 3 miles west of Sage Creek, 15 feet west of monument; iron post stamped "4068"..... 4,078.

North Fork of Flathead River northeast up Logging Creek to Logging Lake.

	Feet.
Flathead road, 1.3 miles northeast of, west side of trail, in top of bowlder; bronze tablet stamped "3676"	3,686.091
Logging Lake, 150 feet southeast of outlet, 260 feet northwest of cabin; iron post stamped "3809"	3,819.153

North Fork of Flathead River along trail up Bowman Creek to Bowman Lake, thence by trail to Lower Quartz Lake.

Bowman Lake, 2.2 miles southwest of, southwest side of trail, in large rock; aluminum tablet stamped "4030"	4,040.115
Bowman Lake, 0.2 mile northwest of outlet, 50 feet west of bank at end of trail; iron post stamped "4046"	4,055.717
Bowman Lake; water surface, Aug. 15, 1903	4,030.2
Bowman Lake, 2 miles east of, 25 feet north of summit; iron post stamped "5116"	5,125.916
Quartz Lake, 200 yards southeast of outlet, 10 feet southwest of trail, in top of large bowlder; bronze tablet stamped "4231"	4,240.444
Lower Bunch Grass Park, 300 feet northeast of exit, in top of bowlder; bronze tablet stamped "3780"	3,791.101

North Fork of Flathead River along trail up Kintla Creek to Kintla Lake.

Kintla Lake; surface of water, July 25, 1903	4,009.2
Kintla Lake, 100 feet northwest of outlet, 50 feet west of shore; iron post stamped "4008 GN"	4,017.739

MIDVALE QUADRANGLE.

Two Medicine Lake south to Midvale, thence northeast along Great Northern Ry. to Durham.

Two Medicine Lake; surface of water	4,862
Two Medicine Lake, 100 feet south of, about 900 feet west of outlet; iron post stamped "4864 GN" (on a side line not checked)	4,872.799
Midvale, 2.8 miles north of, 440 feet north of bridge over Two Medicine Creek, in forks of road; iron post stamped "4812 GN"	4,821.132
Midvale, in front of station, top of rail	4,796.7
Midvale, 100 feet north of water tank, 175 feet west of section house; iron post stamped "4786 GN"	4,796.091

Midvale southwest along Great Northern Ry. to Java.

Midvale, steel bridge over Middle Fork of Two Medicine River, top of pier of east end	4,800.11
Midvale, 4.6 miles southwest of, 0.6 mile southwest of snow shed 4, 0.1 mile east of mile board 1143, 100 feet east of deep shale rock cut, 50 feet northwest of track, in north end of ledge of rock; bronze tablet stamped "4963 GN"	4,973.146
Summit, 4.2 miles east of, 0.3 mile east of trestle 106, 25 feet south of track, 100 feet southeast of crossing of track by rail, in bowlder 3 by 2 feet by 12 inches high; bronze tablet stamped "5051 GN"	5,060.567
Summit, at water tank; top of rail	5,214.3
Summit, 125 feet east of section house, 125 feet south of water tank, in conglomerate bowlder 4 feet square; bronze tablet stamped "5205 GN"	5,215.026
Summit, 4 miles west of, 300 feet east of trestle 112, north of track, near center of rock cut, 300 feet east of milepost 1155; iron bolt cemented in rock stamped "4902 GN"	4,912.171

	Feet.
Bear Creek, at water tank; top of rail	4,684.6
Bear Creek, 1 mile southwest of, 1,000 feet east of tunnel 1, 30 feet north of track, in large red rock; bronze tablet stamped "4595 GN"	4,605.506
Bear Creek, 3.9 miles southwest of, 0.4 mile west of mile board 1161, 10 feet north of track, in rock cut, 1.5 feet higher than rail; iron bolt cemented in rock stamped "4325 GN"	4,335.397

NYACK QUADRANGLE.

Java northwest along Great Northern Ry. to Belton.

Java, 500 feet north of section house, south end of railway bridge over Middle Fork of Flathead River, east end of top of pier level with bridge seat; bronze tablet stamped "3970 GN"	3,979.879
Java, bridge over Flathead River; top of rail	3,987.6
Essex, at water tank; top of rail	3,870.4
Essex, 0.3 mile north of section house, 250 feet east of railroad track, in southeast part of large bluish white outcrop of rock, 3 feet above ground; bronze tablet stamped "3851 GN"	3,860.885
Essex, 3.5 miles west of, 0.5 mile west of mile board 1172, near center of red rock cut, south of track, level with rail; iron bolt cemented in rock stamped "3755 GN"	3,765.319
Paola, in front of section house; top of rail	3,701.5
Paola, 1.4 miles west of, 400 feet east of tunnel 2, 75 feet south of track, in white rock 4 feet high in foot of steep bank; bronze tablet stamped "3671 GN"	3,680.845
Paola, 6.2 miles west of, near west end of rock cut, north of track, 2 feet higher than rail, 650 feet west of mile board 1180; iron bolt cemented in rock stamped "3523 GN"	3,532.808
Nyack, 0.9 mile east of, 150 feet east of water tank, south side of track, at foot of rock cut; bronze tablet stamped "3373 GN"	3,383.077
Nyack, at water tank; top of rail	3,380.5
Nyack, 4.1 miles west of, at mile board 1189, south of track, level with rail, at foot of rock ledge; iron bolt stamped "3282 GN"	3,292.279
Belton, 3.7 miles east of, 0.2 mile west of milepost 1192, in rock cut south of track, 5 feet higher than rail; bronze tablet stamped "3251 GN"	3,260.763

Coram southeast up South Fork of Flathead River 38 miles (single spur line).

Coram, 2.7 miles southeast of, on knoll, west side of trail and 50 yards south of Clayton's cabin, 1 mile south of town road; iron post stamped "3341"	3,351.360
Coram, 4 miles southeast of, east side of trail, 0.2 mile west of creek; nail in root of tamarack tree	3,330.48
Coram, 7.1 miles southeast of, 0.5 mile north of small brook, 10 feet west of trail; nail in root of hemlock tree	3,632.24
Coram, 9.6 miles southeast of, 20 feet above and 100 feet south of trail, 200 feet north of Homjanz Horse hut, southwest edge of isolated ridge, in projecting ledge of rock, 20 feet southwest of large pine; aluminum tablet stamped "3301"	3,311.530
Coram, 12 miles southeast of, 0.2 mile north of large brook and 200 yards south of small brook, on west side of trail; nail in root of spruce tree	3,534.56
Coram, 14.53 miles southeast of, 50 feet north of intersection of trail leading to Spring Meadow and river bank, 0.2 mile east of Spring Meadow, east side of trail; iron post stamped "3247"	3,257.289

	Feet.
Coram, 17.5 miles southeast of, 150 feet south of entrance to Riverside Park, 300 feet south of creek, east side of trail; iron post stamped "3220".	3,230.064
Coram, 20.5 miles southeast of, about 1 mile south of small meadow, east side of trail; nail in root of birch tree	3,385.62
Coram, 22.6 miles southeast of, 65 feet above and 200 feet north of creek, 5 feet south of trail, on top of embankment; iron post stamped "3403"	3,413.255
Coram, 25.6 miles southeast of, 1 mile north of large creek, 0.2 mile west of small meadow, east side of trail; nail in root of balsam tree	3,497.89
Coram, 28.5 miles southeast of, 1 mile north of Trout Lake, west side of trail, at south end of Skunk Root Meadow; iron post stamped "3593"	3,603.402
Coram, 30 miles southeast of, 0.5 mile south of Trout Lake, west side of trail; nail in root of white pine tree	3,703.14
Coram, 33 miles southeast of, 75 feet north of Coal Creek, east side of trail, 50 feet east from river bank and 0.7 mile south of "Coal Bank;" iron post stamped "3365"	3,375.332

URAL QUADRANGLE.

Gateway via Great Northern Ry. to Rexford.[1]

Gateway, 90 feet west of customhouse, on international boundary line; iron post stamped "2355"	2,365.450
Gateway, 0.2 mile south of international boundary line, top of granite base line post, on upper half of letter B; bronze tablet stamped "2371".	2,380.895
Gateway, 1.2 miles south of international boundary line, on top of granite base line post, on upper half of letter B; bronze tablet stamped "2362".	2,372.683
Hayden, 50 feet west of Great Northern Railway water tank, 2 feet east of fence; iron post stamped "2301"	2,311.522
Rexford, 100 feet east of Great Northern Railway (Jennings Branch), opposite town site office; iron post stamped "2277"	2,287.181

Flathead Lake, Horse Plains, Libby, Pend Oreille, Quartz, Ravalli, Thompson, and Trout Creek Quadrangles.

FLATHEAD, MISSOULA, AND SANDERS COUNTIES.

The elevations in the following list were determined by primary leveling. The leveling along the Northern Pacific Railway is adjusted to accord with the elevation at Spokane, Wash., as given in Bulletin 457, and with the elevation at Missoula as computed in 1911, by distributing an excessive error of 3 feet. The leveling up Flathead Valley is part of a net between Butte and the Canadian boundary.

The leveling was done in the Horse Plains, Libby, Pend Oreille, Quartz, Thompson, and Trout Creek quadrangles in 1899 by H. S. Crowe; in the Flathead Lake quadrangle in 1904 by G. H. Kendall; and in the Ravalli quadrangle in 1899 by H. S. Crowe, in 1904 by G. H. Kendall, and in 1907 by N. W. Pilger.

FLATHEAD LAKE QUADRANGLE.

Polson south along stage road to point near Ronan.

	Feet.
Polson, 1,200 feet south of steamboat wharf, 60 feet north of Allard & Seaman's store and post office, 150 feet west of barn; iron post stamped "2908 GN"	2,919.138

[1] The elevations given on this line are computed through railroad cut-off levels from Columbia Falls, corrected for orthometric error.

	Feet.
Polson, 2.7 miles south of, 50 feet south of road forks between roads to Ronan and to Ravalli; iron post stamped "3185 GN"	3,196.063
Polson, 4 miles south of, 100 feet west of road to Selish, 1.5 miles west of small ranches, 1.5 miles northwest of woods, 300 feet west of small dry pond; point on rock 6 feet high	3,187.726
Polson, 5.5 miles south of, on second rise from ridge south of Polson, on south slope near top, 25 feet west of road; iron post stamped "3194 GN"	3,205.163
Polson, 8 miles south of, northwest corner of Stinger's ranch, 0.5 mile north of ranch house, 1,000 feet north of fence corner, 30 feet east of road, at top of rise; iron post stamped "3081 GN"	3,092.195
Polson, 13 miles south of, at Bell's place, 1,200 feet northwest of house, opposite gate to field, 30 feet west of road; iron post stamped "2952 GN"	2,962.467

HORSE PLAINS QUADRANGLE.

Weeksville southeast along Northern Pacific Ry. to Plains.

Milepost "H. 92, HLNA. 206," 55 feet southwest of, 18 feet west of center of track; iron post stamped "2454 T"	2,452.854

LIBBY QUADRANGLE.

Idaho-Montana line southeast along Northern Pacific Ry. to Noxon.

Heron, 150 feet east of east end of station, 20 feet south of center of track; iron post stamped "2256 T"	2,256.083
Smeads, opposite milepost "H. 29, HLNA. 269," 30 feet south of center of track, 100 feet west of east head block of switch; iron post stamped "2169 T"	2,168.755

PEND OREILLE QUADRANGLE.

At Idaho-Montana boundary line.

Idaho-Montana boundary line, at signboard, 15 feet north of track; iron post stamped "2212 T"	2,212.182

QUARTZ QUADRANGLE.

Plains southeast along Northern Pacific Ry. to milepost "H 118."

Plains, in front of telegraph office; top of rail	2,473.8
Plains, 3 feet north of northeast corner of fence around railroad roadmaster's residence, 94 feet west of center of track; iron post stamped "2473 T"	2,472.009
Paradise, 4 feet east of southeast corner of fence at section house, 27 feet north of center of track; iron post stamped "2490 T"	2,488.413
Olive, 1,000 feet south of Mrs. Lynch's house, 50 feet north of center of track, 4 feet east of telegraph pole; iron post stamped "2499 T"	2,497.187
Milepost "H. 113, HLNA. 185," 12 feet northeast of, 15 feet south of center of track; iron post stamped "2502 T"	2,500.439
Milepost "H. 118, HLNA. 180," 72 feet southwest of, 24 feet south of railroad track; iron post stamped "2508 T"	2,506.079

RAVALLI QUADRANGLE.

Milepost "H 118" along Northern Pacific Ry. southeast to Ravalli, thence south to Evaro.

Milepost "H. 123, HLNA. 175," 480 feet west of, 15 south of center of track; iron post stamped "2510 T"	2,508.071
Joco, 1 foot north of fence opposite station, 240 feet south of center of track; iron post stamped "2521 T"	2,519.462
Joco, in front of station; top of rail	2,520.1

	Feet.
Milepost "H. 134, HLNA. 164," 60 feet east of, 40 feet south of center of track; iron post stamped "2643 T"	2,641.595
Ravalli, in front of telegraph office; top of rail	2,702.12
Milepost "H. 140, HLNA. 159," 70 feet west of, 21 feet north of track; iron post stamped "2815 T"	2,813.052
Arlee, in front of telegraph office; top of south rail	3,082.2
Arlee, 85 feet west of west corner of Chinese bunk house, 100 feet south of center of track, 165 feet southwest of milepost "H. 146, HLNA. 152;" iron post stamped "3093 T"	3,091.005
Milepost "H. 151, HLNA. 147," 240 feet east of, 15 feet north of track; iron post stamped "3561 T"	3,558.946
Evaro, at center of station; top of south rail	3,955.7
Evaro, 0.25 mile east of, 58 feet northwest of road crossing, 30 feet south of center of track, 200 feet southwest of milepost "H. 157, HLNA. 141;" iron post stamped "3957 T"	3,955.439

Point 1 mile south of Frenchtown east to point 2.2 miles west of Ninemile.

Frenchtown, 600 feet southwest of Northern Pacific Railway station, 120 feet west of bridge across stream, 30 feet north of road, in bowlder; aluminum tablet stamped "3034"	3,036.359
Frenchtown, 2.5 miles west of, 600 feet northeast of Bramen Lavoier's ranch house, south side of road, in bowlder; aluminum tablet stamped "3025"	3,028.137
Huson, 1 mile west of, 400 feet southwest of Peter Shafer's cabin, 500 feet southwest of bridge across Sixmile Creek, 5 feet south of road, in rock; aluminum tablet stamped "3006"	3,008.557
Ninemile, 80 feet south of post office and hotel, 10 feet northeast of road, in small bowlder; aluminum tablet stamped "2992"	2,994.785
Ninemile, 1.8 miles west of, 0.2 mile east of Eddy's ranch house, 15 feet northwest of road, in bowlder; aluminum tablet stamped "3022"	3,024.838

Near Ronan south along stage road to Ravalli.

Polson, 17.5 miles south of, on second rise south from Crow Creek, 18 feet west of stage road; iron post stamped "3003 GN"	3,014.423
Post Creek, 4 miles north of, 15 feet east of wagon road, in middle of level stretch; iron post stamped "2933 GN"	2,943.912
Post Creek, 1.5 miles north of, 20 feet east of road, on south slope toward creek, 20 feet northwest of large rock; iron post stamped "2849 GN"	2,860.036
Mission Creek, 200 feet south of, 30 feet west of road; iron post stamped "2739 GN"	2,750.480
Ravalli, 1 mile north of, south of summit of ridge, 90 feet north of fork of stage road to Polson, and road to Indian Mission; iron post stamped "3104 GN"	3,115.461

THOMPSON QUADRANGLE.

White Pine southeast along Northern Pacific Ry. to Weeksville.

White Pine, 12 feet west of car house, 18 feet east of corner of fence, 25 feet north of center of track; iron post stamped "2583 T"	2,582.317
Milepost "H. 62, HLNA. 236," 365 feet northwest of, 21 feet south of center of track; iron post stamped "2527 T"	2,526.496
Belknap, in front of station; base of rail	2,402.5
Milepost "H. 66, HLNA. 232," 240 feet east of, at end of through cut, 25 feet north of center of railroad track, 360 feet east of east end of bridge 280 [redacted] Clark Fork; iron post stamped "2389 T"	2,387.767

	Feet.
Thompson Falls, 40 feet east of east end of station, 16 feet south of center of track, 6 feet east of telegraph pole; iron post stamped "2439 T."	2,437.9
Milepost "H. 76, HLNA. 222," 1 mile east of, 22 feet south of center of track; iron post stamped "2433 T"	2,431.6
Eddy, 27 feet west of west end of telegraph office, 15 feet south of center of track, 30 feet east of milepost "H. 82, HLNA. 216;" iron post stamped "2428 T"	2,426.9
Milepost "H. 87, HLNA. 211," 22 feet east of, 24 feet north of center of track; iron post stamped "2444 T"	2,443.3

TROUT CREEK QUADRANGLE.

Noxon southeast along Northern Pacific Ry. to White Pine.

Noxon, in front of telegraph office; top of rail	2,180.0
Noxon, 40 feet east of east corner of station, 13 feet north of center of track; iron post stamped "2182 T"	2,181.5
Milepost "H. 38, HLNA. 260," 420 feet southeast of, 30 feet south of track; iron post stamped "2210 T."	2,209.0
Tuscor, 33 feet southeast of southeast corner of section house, 49 feet west of center of track; iron post stamped "2232 T"	2,231.4
Trout Creek, 16 feet west of west end of telegraph office, 18 feet from center of track, 18 feet east of milepost "H. 48, HLNA. 250;" iron post stamped "2371 T"	2,370.2
Vermilion, 150 feet east of road crossing at west end of through cut, south side of railroad, 18 feet north of center of track; iron post stamped "2482 T"	2,481.3

Bonner, Drummond, Gibbons Pass, Hamilton, Missoula, Ovando, Philipsburg, Sapphire, and Trapper Peak Quadrangles.

DEERLODGE, GRANITE, MISSOULA, POWELL, AND RAVALLI COUNTIES.

The elevations in the following list were determined by primary leveling as adjusted in 1911.

The leveling was done in the Bonner quadrangle in 1898 by F. E. Whitlock, in 1900 by J. T. Stewart, and in 1905 and 1906 by F. E. Fellows; in the Drummond quadrangle in 1898 by F. B. Whitlock, in 1900 by J. T. Stewart, in 1904 by G. H. Kendall, and in 1905 by F. E. Fellows; in the Hamilton quadrangle in 1897 by C. M. Kurtz and in 1906 by F. E. Fellows; in the Missoula quadrangle in 1898 by F. B. Whitlock, in 1899 by H. S. Crowe, and in 1900 by J. T. Stewart; in the Philipsburg quadrangle in 1905 by F. E. Fellows; in the Sapphire quadrangle in 1905 and 1906 by F. E. Fellows; and in the Trapper Peak and Gibbons Pass quadrangles in 1897 by C. M. Kurtz.

BONNER QUADRANGLE.

Missoula east along Northern Pacific Ry. to Nimrod (double-run line).

	Feet.
Missoula, in front of station; top of rail	3,206.8
Missoula, First National Bank building, southeast corner of Higgins Avenue and Front Street, right side of entrance; bronze tablet stamped "3201 T"	3,199.4
Missoula, Montana State University building, left side of main entrance; bronze tablet stamped "3225 T"	3,223.4

	Feet.
Missoula, Montana State University grounds; south meridian mark stamped "3220 MSLA"	3,217.974
Missoula, Montana State University grounds; north meridian mark stamped "3220 MSLA"	3,218.155
Missoula, 4 miles east of, at fork of county and toll roads, 100 feet west of railroad; iron post stamped "3249 MSLA"	3,246.490
Bonner, southeast corner of Margaret Hotel grounds; iron post stamped "3297 MSLA"	3,295.429
Turah, southeast corner of section house; iron post stamped "3325 MSLA"	3,323.395
Clinton, 3 miles west of, 20 feet north of road at railroad crossing; iron post stamped "3416 MSLA"	3,414.363
Clinton, northeast corner of Federation of Labor hall, 200 feet west of railroad track, opposite milepost 107; iron post stamped "3467 MSLA"	3,465.359
Clinton, 3 miles southeast of, 1,000 feet south of milepost 104, 50 feet east of crossing of railroad and wagon road; iron post stamped "3509 MSLA"	3,507.324
Scepter spur, 100 feet south of county bridge over Hell Gate River; iron post stamped "3544 MSLA"	3,542.324
Bonita, southeast corner of post office, in road in front of Mr. Cook's residence; iron post stamped "3582 MSLA"	3,580.292
Bonita, 3 miles east of, south side of road, at gate to Will's ranch, 300 feet north of old corduroy bridge over Hell Gate River; iron post stamped "3648 MSLA"	3,646.299
Nimrod, 200 feet north of section house, north side of road; iron post stamped "3696 MSLA"	3,694.262

Missoula up Rattlesnake Canyon (double spur line).

Missoula, 3 miles north of, north and west side of road, at angle in road; iron post stamped "3436 MSLA"	3,434.548
Missoula, 5.5 miles north of, 600 feet west of Effenger's house, 300 feet east of bridge across Rattlesnake Canyon; iron post stamped "3648 MSLA"	3,646.410

Bonner east via Blackfoot River to Gilbert's ranch (double-run line as far as Potomac).

Bonner, 3 miles east of, 10 feet west of the north end of county bridge over Blackfoot River; iron post stamped "3288 MSLA"	3,286.428
Bonner, 6 miles northeast of, 10 feet from north end of old county bridge, 20 feet south of road; iron post stamped "3350 MSLA"	3,348.263
Twin Creeks, southeast corner of M. R. Stairs's house, 20 feet north of road; iron post stamped "3411 MSLA"	3,409.424
Potomac, 4 miles west of, 15 feet north of road, at gate leading to J. Davis's ranch; iron post stamped "3519 MSLA"	3,517.423
Potomac, 100 feet west of post office; iron post stamped "3619 MSLA"	3,617.418
Gilbert's ranch, 15 feet southwest of intersection of roads; iron post stamped "3759 MSLA"	3,757.075

Scepter Spur up Rock Creek via Quigley and Ranch Creek (double-run line).

Gilbert Gulch, mouth of, fork of road to Johnson's sawmill; iron post stamped "3646 MSLA"	3,643.424
Quigley, corner of Emmons Avenue and Third Street; iron post stamped "3834 MSLA"	3,832.299
Quigley, 3 miles south of, near mouth of Ranch Creek, northeast corner of Paul's house; iron post stamped "3960 MSLA"	3,958.332
Ranch Creek, 2.5 miles southeast of mouth of, 50 feet west of crossing of Ranch Creek by wagon trail, at south side of trail; iron post stamped "4189 MSLA"	4,186.999

	Feet.
Quigley, 5 miles southwest of, 0.5 mile northeast of mouth of Welcome Gulch, opposite small stream from west, 15 feet south of trail, 75 feet southeast of Rock Creek; iron post stamped "3965 MSLA"	3,963.297
Quigley, 8 miles southwest of, 2.5 miles southwest of Welcome Gulch, 50 feet east of Rock Creek, 25 feet above water, west side of trail, in bowlder 4 by 3 feet and 2.5 feet high; aluminum tablet stamped "4067 MSLA"	4,064.789

Point 8 miles southwest of Quigley southwest to point 0.2 mile south of Ford 20, on Rock Creek.

Ford 20, Rock Creek, 0.2 mile south of, 0.6 mile north of log cabin, 6 feet east of trail, 220 feet west of creek, in large quartzite bowlder; aluminum tablet stamped "MSLA 4196"	4,193.374

Quigley southeast to Willow Creek.

Quigley, 2.5 miles southeast of, 40 feet south of Brewster Creek, 5 feet south of road; iron post stamped "MSLA 4127"	4,125.457
Quigley, 5.9 miles southeast of, 30 feet east of road, 150 feet east of gulch, west face of rock ledge; bronze tablet stamped "MSLA 5137"	5,135.344
Quigley, 7.6 miles southeast of, at forks of road leading to Jumbo mines, south side of road, north side of rock ledge; bronze tablet stamped "MSLA 6095"	6,093.441
Quigley, 9.6 miles southeast of, 4 feet west of road, 300 feet north of forks of road on summit; iron post stamped "MSLA 7117"	7,115.439
Quigley, 12.6 miles southeast of, 0.4 mile southeast of summit, 6 feet south of road; iron post stamped "MSLA 7056"	7,053.434
Quigley, 15.4 miles southeast of, 1 mile west of Willow Creek, 4 feet south of road; iron post stamped "6189 MSLA"	6,187.436

Dwyer's ranch to Threemile Creek.

Dwyer's ranch, 3.7 miles northeast of, north side of road; iron post stamped "3912 MSLA"	3,910.208
Cleveland mine, on divide between Bitterroot Valley and Rock Creek, 300 feet east of head of Threemile Creek and Welcome Gulch, north side of trail; iron post stamped "7182 MSLA" (unchecked)	7,180.637

Dwyer's ranch southeast along Ridge road north of Ambrose Creek to Richard's ranch.

Threemile schoolhouse, 0.8 mile south of, 100 feet northwest of fork of road, north side of road near fence; iron post stamped "3553 MSLA"	3,551.224
Richard's ranch, 1.4 miles southeast of, southwest bank of timbered ravine, 30 feet south of road; iron post stamped "4653 MSLA"	4,651.143

Hayes siding up Miller Creek road to Hayes's sawmill (double-run line).

Deberge (or Belgian) ranch, 75 feet southwest of, north side of road near fence; iron post stamped "3764 MSLA"	3,761.887
Davis's ranch, 400 feet southwest of, 700 feet west of site of upper setting of Hayes's sawmill, north side of road near fence; iron post stamped "4037 MSLA"	4,034.994

DRUMMOND QUADRANGLE.

Nimrod east along Northern Pacific Ry. to Garrison.

Nimrod, 3 miles east of, opposite milepost "89 HLNA", 500 feet east of road crossing, outside right of way, south of track, 20 feet north of road, 50 feet north of small log bridge; iron post stamped "3727 MSLA"	3,725.016

	Feet.
Bearmouth, 2 miles west of, 2,449 feet southeast of northwest corner of sec. 21, T. 11 N., R. 14 W., south of track; iron post stamped "3788 MSLA" (as reset by railroad company, 2.33 ft. higher than original position)	3,788.485
Bearmouth, 1 mile east of, 0.25 mile east of milepost "83 HLNA", 60 feet south of track, inside fence, west of cut, east of fill; iron post stamped "3821 MSLA"	3,819.052
Hellgate, 1 mile west of, 400 feet southwest of milepost "80 HLNA", 140 feet southeast of track, on southwest side of knoll in Howe's place; iron post stamped "3853 MSLA" (position as reset by railroad company, but elevation may not be correct)	3,850.897
Hellgate, 2 miles east of, at milepost "77 HLNA", on top of bank northeast of track, on fence line; iron post stamped "3926 MSLA"	3,923.931
Drummond, 2 miles west of, 1,000 feet east of milepost "74 HLNA", 1 foot north of fence, 100 feet north of track, in low level place 500 feet south of road; iron post stamped "3914 MSLA"	3,911.909
Drummond, 1 mile east of, opposite milepost "71 HLNA", 50 feet south of track, 2 feet south of fence in field; iron post stamped "3962 MSLA"	3,959.888
Drummond, 4 miles east of, opposite milepost "68 HLNA", north of track, 2 feet north of fence, 300 feet south of road; iron post stamped "4014 MSLA"	4,011.904
Haskell, east end of siding, opposite milepost "65 HLNA", 100 feet north of track, in field, 700 feet northwest of switch stand; iron post stamped "4079 MSLA"	4,077.001

Point near Potomac northeast along highway to Clearwater schoolhouse.

Gilbert's ranch, 3.1 miles northeast of, south side of road, northeast side of small circular marshy flat in ravine; iron post stamped "4012 MSLA"	4,010.472
Sunset Valley, 300 feet west of Clem's ranch, north side of road at corner of fence; iron post stamped "3765 MSLA"	3,763.079
Sunset schoolhouse, 1.5 miles northeast of, 3 miles southwest of Clearwater post office, top of divide between Elk Creek and Big Blackfoot River, 200 feet southeast of road, in red rock 6 by 8 feet and 1 foot high, bronze tablet stamped "3965 MSLA"	3,963.509
Clearwater, 300 feet southeast of post office, 300 feet northeast of bridge over Blackfoot River, east side of road near fence; iron post stamped "3775 MSLA"	3,773.031
Clearwater, 1.5 miles northeast of schoolhouse, in edge of timber east of road; iron post stamped "3846 MSLA"	3,844.094

Drummond via Flint to Philipsburg.

Drummond, 2.7 miles south of, at forks of road 0.3 mile west of Northern Pacific Ry. crossing, southwest corner of fence in field, 10 feet west of irrigating ditch, in top of small bowlder; bronze tablet stamped "MSLA 4049"	4,047.044
New Chicago, 2.5 miles southeast of, small summit at triangulation station of that name, 6 feet south of signal, on small bowlder, aluminum tablet stamped "MSLA 4513"	4,510.619
New Chicago, 2.5 miles southeast of New Chicago triangulation station; iron post stamped "4514 MSLA"	4,511.893
Hall, 2 miles northeast of, 250 feet east of Pat Brogan's house, 20 feet north of gate, in field, 2 feet west of corner of fence, on small bowlder; bronze tablet stamped "MSLA 4148"	4,145.876
Hall, 2.3 miles southeast of, 150 feet west of Frank Johnson's house, 30 feet east of creek, west side of road; iron post stamped "MSLA 4236"	4,233.901

	Feet.
Stone, 2.5 miles north of, 30 feet east of road, 100 feet north of stone cellar, 700 feet northeast of log house, 50 feet west of quartz ledge, in top of quartz bowlder; bronze tablet stamped "4370 MSLA"	4,367.911

GIBBONS PASS QUADRANGLE.

Fork Bridge southeast up East Fork to Ross Hole.

Sula, 0.25 mile north of post office, 7 feet east of blazed stump west of road; highest point of 12 by 18 inch rock	4,430.18
Ross Hole, 3.5 feet north of corner of sections 8, 9, 16, and 17, T. 1 N., R. 19 W.; iron post stamped "4384"	4,432.723

HAMILTON QUADRANGLE.

Hamilton via Northern Pacific Ry. to Grantsdale.

Hamilton, in top of astronomical pier of United States Geological Survey, on east side of Northern Pacific Ry., opposite station; bronze tablet, stamped "3524"	3,573.077
Grantsdale, in front of baggage-room door; top of rail nearest station	3,641.3
Grantsdale, north side of schoolhouse, 11 feet 8½ inches from northeast corner; bronze tablet stamped "3627"	3,676.032

Grantsdale via Como and Darby to Fork Bridge.

Grantsdale, 2.5 miles south of, at road fork, 3 feet inside of rail fence and 2 feet 10 inches southwest of signpost reading "9 miles to Weeping Child Hot Springs"; iron post stamped "3636"	3,684.885
Sheep Flat, on river side of road, 50 feet north of sharp bend 3 miles south of Grantsdale; T cut in higher part of granite bowlder	3,702.77
Como, 0.8 mile north of, east of road; small circular projection on large piece of granite	3,801.52
Harlans Bridge, beam on lower side of east abutment; head of driftbolt	3,789.83
Harlans Bridge, 0.1 mile above, at junction of road from Lost Horse with main road in a field on north side of road 3 feet from fence and 47 feet S. 50° W. (magnetic) from large pine tree in same field; iron post stamped "3731"	3,779.476
Rock Creek Bridge, 1 mile south of, west side of road; head of nail in bench cut in large pine tree (N. P. Ry. bench mark)	3,816.52
T. 4 N., R. 21 W., 35 feet west and 20 feet north of corner of secs. 34 and 35; iron post stamped "3802"	3,850.467
Darby, northeast corner of Darby drug store; head of nail in plug	3,879.68
Darby, 1 feet 8 inches east and 17½ feet north of northwest corner of fence in yard of Hammond's Hotel; iron post stamped "3832"	3,880.733

West up Rock Creek valley to Lake Como.

Lake Como, in a large bowlder on bank of lake, between hotel and cattle corral, and 75 feet south of the road; copper bolt stamped "U. S. G. S. 4167"	4,215.812

Hamilton east to foothills and south along foothills to Skalkaho Creek and Hamilton waterworks reservoir, thence west to Grantsdale.

Bitterroot stock farm, water tank at foot of hill east of, on most easterly part of a large bowlder 70 feet west of largest of a clump of pine trees; highest point	3,931.73
Hamilton waterworks reservoir, in north wall, 130 feet east of the northwest corner; iron post stamped "3776"	3,824.688

Hamilton north along Northern Pacific Ry. to Woodside.

	Feet.
Blodgett Creek, near trestle over, in small fir stump 60 feet west of track; head of nail in bench cut	3,500.17

Woodside east along road via Corvallis to foothills, thence north along east edge of valley to Stevensville.

Corvallis, under front wing on south side of northwest corner of foundation of schoolhouse; bronze tablet stamped "3428"	3,476.269
T. 7 N., R. 20 W., 3 feet northwest of southeast corner of sec. 15; iron post stamped "3537"	3,585.201
T. 8 N., R. 20 W., southwest corner of SE. ¼ sec. 34; 4 feet north of fence on township line; iron post stamped "3375"	3,423.146
T. 8 N., R. 20 W., 30 feet 7 inches north of south corner between secs. 14 and 15; iron post stamped "3322"	3,370.583

Stevensville south on west side of Bitterroot River to Woodside.

Tps. 8 and 9, R. 20 W., where township line crosses Northern Pacific Railway, in large pine tree 70 feet east of track; head of nail in bench cut	3,294.25
Curlew mine, at northwest corner of office; iron post stamped "3533"	3,581.455
T. 8 N., R. 21 W., 9 feet northeast of south corner of secs. 34 and 35; iron post stamped "3614"	3,662.634
Woodside, 3 miles north of, 33 feet from southwest corner of sec. 18, T. 7 N., R. 20 W., 8 feet north of section line; iron post stamped "3423"	3,471.575

Rock Creek west along road via sand basin to Corvallis (portion of line).[1]

Corvallis, 5.2 miles southeast of, 600 feet east of C. Boucher's ranch house, 250 feet east of bridge, center of road, in top of granite bowlder; aluminum tablet stamped "MSLA 4102"	4,099.948

MISSOULA QUADRANGLE.

O'Keefe trestle south along Northern Pacific Ry. to Missoula (part of double-rodded line from Pasco, Wash.).

Desmet, 30 feet west of road crossing in front of station, 45 feet south of main track; iron post stamped "3225 T"	3,222.984
Desmet, in front of station; top of rail	3,224.6
McLeod's siding, 0.5 mile east of, opposite cemetery, 4 feet east of telegraph pole, 50 feet southwest of center of track; iron post stamped "3186 T"	3,184.242

Missoula south along Bitterroot branch of Northern Pacific Ry. to Stevensville.

Bitterroot, 0.5 mile north of station, 35 feet northwest of road crossing, 400 feet south of milepost 3; iron post stamped "3172 MSLA"	3,169.876
Buckhouse ranch, 600 feet southeast of, 75 feet northwest of west end of wagon bridge, 150 feet east of road crossing; iron post stamped "3140 MSLA" (U. S. G. S. Water Resources Branch station)	3,137.762
Hayes siding, 225 feet southwest of Miller Creek, wagon road crossing; wire nail in root of 30-inch pine tree	3,133.860
Kennedy's ranch, 0.5 mile north of, 150 feet south of milepost 9, 90 feet west of railroad, west side of wagon road, near fence; iron post stamped "3143 MSLA"	3,141.062
Lolo, 65 feet west of station, north side of road near fence, 74 feet west of railroad, 200 feet southwest of milepost 11; iron post stamped "3185 MSLA"	3,183.151

[1] This is an unadjusted line closing 1.1 feet low.

McClain's ranch, 400 feet southeast of, 325 feet west of railroad, east side of wagon road, near fence; iron post stamped "3173 MSLA" ..... Fee 3,17
Carlton, 85 feet west of station, south side of county road, near fence; iron post stamped "3199 MSLA" 3,19
Florence, 85 feet south of schoolhouse, 300 feet west of railroad, north side of wagon road, near fence; iron post stamped "3271 MSLA" 3,26
Stevensville, 2.5 miles north of, 45 feet southwest of Stevensville and Florence wagon-road crossing, near fence corner; iron post stamped "3264 MSLA" 3,26
Stevensville, 100 feet east of station, corner of fence north of road; iron post stamped "3310 MSLA" 3,30
Stevensville, in wall at southeast corner of old courthouse building; bronze tablet stamped "3271 N. P." 3,31

Stevensville east to Dwyer's ranch.

Smith's ranch, 40 feet northwest of, 3.5 miles northeast of Stevensville, 1,250 feet east of county road, at mouth of small timbered gulch; iron post stamped "3330 MSLA" 3,32
Dwyer's ranch, 15 feet north of yard gate, east of road near fence; iron post stamped "3397 MSLA" 3,39

Hayes siding up Miller Creek road to Williams's ranch.

Williams's ranch, 50 feet south of, 250 feet east of intersection of short road to Missoula with Miller Creek Road; iron post stamped "3388 MSLA" 3,38

Desmet northwest to point 1 mile south of Frenchtown.

Desmet, 2.5 miles west of, 1 mile west of Barrett's ranch house, 10 feet west of road, in gneiss bowlder; aluminum tablet stamped "3217" 3,21
Desmet, 6 miles west of, 0.2 mile west of Bourgon's ranch house with red roof, 150 feet north of road, on hillside, in gneiss bowlder 3 feet by 2 feet; aluminum tablet stamped "3169" 3,16

Lothrop south along Petty Creek over divide and along Grave Creek to its junction with Lolo Creek, thence east along Lolo Creek to Lolo.

Lothrop, 50 feet north of Northern Pacific Railway station, 5 feet east of sidewalk, midway between station and Hotel Lothrop, in bowlder; aluminum tablet stamped "2958" 2,96
Lothrop, 3 miles south of, up Petty Creek, 900 feet north of vacant cabin, 300 feet south of creek ford, 15 feet west of road, in bowlder 4 feet high; aluminum tablet stamped "3207" 3,20
Lothrop, 5.5 miles south of, up Petty Creek, 600 feet up creek from a bridge, 10 feet north of road, in rock near log painted "3425;" aluminum tablet stamped "3423" 3,42
Lothrop, 9 miles south of, 2 miles south of Schmitz Bros.' sawmill on Petty Creek, 0.5 mile north of log cabin, 5 feet east of road, in bowlder; aluminum tablet stamped "3677" 3,67
Lothrop, 12.1 miles south of road crossing over divide between Petty and Grave creeks, 0.8 mile north of south side of road, in root of fir tree; nail with aluminum tag marked "4181" 4,18
Lothrop, 15 miles south of, on road summit over divide between Petty and Grave creeks, 5 feet east of road, in bowlder; aluminum tablet stamped "4416" 4,41

	Feet.
Junction of Lolo and Grave creeks, 3.5 miles north of, midway between upper two bridges on west fork of Grave Creek, 5 feet east of road, in bowlder 3 feet high; aluminum tablet stamped "4027"	4,029.759
Lolo Hot Springs, 9.5 miles east of, at the confluence of Grave and Lolo Creeks, 150 feet west of log stable, 10 feet north of road, 100 feet west of Grave Creek ford, in rock; aluminum tablet stamped "3784"	3,786.393
Lolo Hot Springs, 12 miles east of, in root of tree on which a 12-inch sign is nailed 6 feet above bench-mark point; nail marked "3700"	3,702.77
Lolo Hot Springs, 12.2 miles east of, 1.2 miles west of Schmitz ranch, on north side of Lolo Creek, about 400 feet east of grade summit north of road; aluminum tablet stamped "3712" (description is of new location after bench mark was moved on account of railroad construction)	3,714.264
Lolo Hot Springs, 14 miles east of, 0.8 mile east of Schmitz ranch, on Lolo Creek, 50 feet west of 14-mile sign, in root of tree on east side of road; aluminum tag stamped "3630"	3,632.23
Lolo Hot Springs, 15 miles east of, 500 feet west of L. Lubecke's ranch house, on Lolo Creek, south side of road, 30 feet north of gate, in bowlder; aluminum tablet stamped "3583"	3,585.933
Halfway House (Woodmen), 2 miles east of, 8 miles west of Lolo, 0.5 mile west of Anderson's ranch house, 600 feet west of a peculiar cornered log house, 10 feet south of road between road and irrigating ditch, in rock; aluminum tablet stamped "3462"	3,465.704
Lolo, 5 miles west of, 60 feet south of flume, in root of pine tree on south side of road; nail; aluminum tag in side of tree stamped "3358"	3,360.51
Lolo, 5 miles west of, 0.5 mile east of Thomas Moyer's ranch, near road summit on hill grade, 10 feet west of road, 0.5 mile west of Thompson's ranch, in rock; aluminum tablet stamped "3406"	3,408.507
Lolo, 3 miles west of, 600 feet southwest of large white house 20 feet north of road, in rock; aluminum tablet stamped "3266"	3,268.216
Lolo, 65 feet west of station, north of road near fence, 75 feet west of railroad, 200 feet south of 11-mile post; iron post stamped "3185 MSLA"	3,183.151

Junction of Grave and Lolo creeks west along Lolo Creek to Lolo Hot Springs and return (double spur line).

Lolo Hot Springs, 6 miles east of, 200 feet west of 6-inch sign, 25 feet south of road, in bowlder, "U. S. B. M." painted on rock near by; aluminum tablet stamped "3896"	3,898.749
Lolo Hot Springs, 5.5 miles east of, north side of road, in root of 3-foot tree; nail with aluminum tag stamped "3897"	3,899.61
Lolo Hot Springs, 0.5 mile east of, east side of road between road and creek, in log; nail marked "4093"	4,095.02
Lolo Hot Springs, in top of first large bowlder up creek, 400 feet northwest of post office; aluminum tablet stamped "4168"	4,170.980
James Martin's ranch on Lolo Creek, 70 feet north of house, southeast side of creek, 2.5 miles east of Lolo Hot Springs, in rock; aluminum tablet stamped "4054"	4,056.814
Lolo Hot Springs, 2.8 miles east of, 0.8 mile east of Martin's ranch, top of a small rise in road, 15 feet north of road, in bowlder; aluminum tablet stamped "4032"	4,034.665

Buckhouse Bridge northwest to Bisson's ranch, near Desmet.

McCloy's ranch, 0.1 mile northwest of, 20 feet west of road, near fence, in bowlder; aluminum tablet stamped "3191"	3,193.570
R. Sharp's ranch house, 200 feet northeast of, west of road, 40 feet north of gate, in bowlder; aluminum tablet stamped "3088"	3,090.811

	Feet
H. A. Jacghin's ranch house, 0.8 mile down river from, 5 feet east of road, 100 feet north of turn out, in rock; aluminum tablet stamped "3120"	3,122.
Deep Creek Ferry across Missoula River, 0.5 mile south of, east side of road at top of hill; nail in root of pine tree; marked by aluminum tag stamped "3262" in side of tree	3,264.
Deep Creek Ferry across Missoula River, 0.2 mile south of, 70 feet west of log corral, 120 feet southeast of log cabin, 30 feet west of road, in rock; aluminum tablet stamped "3150"	3,152.
De Show ranch, 400 feet south of house, on south side of a Coeur d'Alene railroad bridge; bolthead with circle of paint, marked "3088"	3,089.
Frenchtown, 5.5 miles east of, on mail road from Missoula, 400 feet north of Thomas Lovous's ranch house, east of road, 25 feet south of telephone pole, in nest of bowlders; aluminum tablet stamped "3060"	3,062.

OVANDO QUADRANGLE.

Clearwater schoolhouse east along highway to Lynn ranch.

Sperry's ranch, 1.1 miles southwest of, 700 feet from Blackfoot River, east of road; iron post stamped "3883 MSLA"	3,881.
Zaya's ranch, 1.3 miles northeast of, 1.2 miles northeast of bridge over Cottonwood Creek, south of east and west road; iron post stamped "3974 MSLA"	3,972.
Monture Creek schoolhouse, 100 feet north of, 275 feet west of Monture Creek, south of road; iron post stamped "4029 MSLA"	4,027.
Ovando, 250 feet east of post office, 50 feet east of Moser's yard gate; iron post stamped "4101 MSLA"	4,099.
Terrell's ranch, 600 feet west of, 1,100 feet west of bridge over North Fork of Blackfoot River, north side of track, in road, in flat granite rock 4 by 5 feet; aluminum tablet stamped "4087 MSLA"	4,085.6
Terrell's ranch, 3.4 miles southeast of, 3.3 miles southeast of iron bridge over North Fork of Blackfoot River, west of chain of lakes, south of road; iron post stamped "4347 MSLA"	4,345.2

PHILIPSBURG QUADRANGLE.

Wilbur Creek southeast to Philipsburg.

Philipsburg, 22.4 miles northwest of, 1 mile north of Maloney's cabin, 4 feet east of road; iron post stamped "MSLA 5748"	5,745.
Philipsburg, 19.5 miles northwest of, 1,800 feet north of forks of road leading to Philipsburg, 15 feet northeast of gate to Grant's house; iron post stamped "MSLA 5489"	5,486.
Philipsburg, 13.1 miles northwest of, 600 feet east of Willow Creek, 40 feet west of road, east side of rail fence, mouth of gulch; iron post stamped "MSLA 5105"	5,102.
Philipsburg, 8.9 miles northwest of, 15 feet northwest of road, top of divide between Marshall and Rock Creeks; iron post stamped "MSLA 6050"	6,047.
Philipsburg, 6.1 miles northwest of, at forks of road 60 feet west of creek, 100 feet northwest of fence corner; iron post stamped "MSLA 5370"	5,367.
Philipsburg, 2.8 miles west of, forks of road 60 feet north of creek, at corner of fence; iron post stamped "MSLA 5207"	5,204.
Philipsburg, high-school building, east side of northeast corner, in granite foundation; aluminum tablet stamped "MSLA 5273"	5,270.

Stone south along highway to Philipsburg.

	Feet.
Stone, 1.1 miles south of, 100 feet south of blacksmith shop, 150 feet south of Wickburg's house, 60 feet east of Northern Pacific Railway, 50 feet west of road, in top of granite bowlder; bronze tablet stamped "4623 MSLA".	4,620.960
Flint, 100 feet south of saloon, 80 feet south of forks of road leading up Boulder Creek, 50 feet west of stable, 10 feet west of road, in granite bowlder; bronze tablet stamped "4857 MSLA"	4,855.044
Flint, 3.4 miles south of, 30 feet east of Northern Pacific Railway, 100 feet east of creek, 0.25 mile southeast of log cabin, in top of bowlder; bronze tablet stamped "4911 MSLA"	4,909.033
Philipsburg, 4.8 miles north of, 200 feet east of Northern Pacific Railway, 10 feet east of road, 0.5 mile south of house; iron post stamped "MSLA 5005"	5,002.998
Philipsburg, 3.3 miles north of, 300 feet north of house, 300 feet north of forks of road leading west to Black Pine, 450 feet northeast of crossing of Black Pine road and Northern Pacific Railway, 50 feet north of road, in bowlder; bronze tablet stamped "MSLA 5036"	5,034.010

Anaconda west along highway to Carey ranch.

Anaconda, 6 miles northeast of, 0.25 mile west of schoolhouse, 200 feet southeast of unpainted house, south of road; iron post stamped "5605 MSLA"	5,602.572
Anaconda, 9 miles northwest of, 0.75 mile west of road to Olesons Gulch, south side of road, top of small summit; iron post stamped "5867 MSLA".	5,864.578
Anaconda, 11.5 miles northwest of, 0.5 mile west of blacksmith shop, 200 feet southeast of log house; iron post stamped "5994 MSLA"	5,991.582
Anaconda, 14.25 miles northwest of, 500 feet west of log house, 800 feet north of creek, north side of road; iron post stamped "6398 MSLA"	6,395.594
Anaconda, 16.5 miles northwest of, 300 feet west of Silver Lake, 0.5 mile southwest of hotel, 0.5 mile southeast of Gold Coin mill, 4 feet south of road, at summit, in top of granite bowlder; aluminum tablet stamped "6443 MSLA"	6,440.623
Anaconda, 19 miles northwest of, 300 feet east of Georgetown Lake, 0.5 mile northeast of log house, 150 feet north of point of pine timber, 10 feet east of road; iron post stamped "6381 MSLA"	6,378.542
Anaconda, 22.4 miles northwest of, 1.5 miles west of Georgetown Lake, 15 feet west of road, summit between Georgetown Lake, Rock Creek, and Trout Creek; iron post stamped "6794 MSLA"	6,791.545

Carey ranch north along highway to Philipsburg (double-run line).

Anaconda, 25.4 miles northwest of, 1 mile northwest of Carey ranch, 30 feet west of road in small valley; iron post stamped "5921 MSLA"	5,918.452
Anaconda, 28.7 miles northwest of, at forks of Rock Creek and Trout Creek roads, 70 feet east of dry creek and 800 feet west of Trout Creek; iron post stamped "5417 MSLA"	5,414.340
Anaconda, 31.4 miles northwest of, at forks of Georgetown and Trout Creek roads, east side of road, 5 feet east of irrigating ditch, 350 feet south of Snavly's house, 1,000 feet east of log schoolhouse; iron post stamped "5404 MSLA"	5,401.404
Philipsburg, 3 miles south of, summit in road intersection of telegraph line and road, west side of road, at west base of butte; iron post stamped "MSLA 5324"	5,321.368

Forks of road 3 miles south of Cable via Georgetown and Rumsey to Philipsburg.

	Feet.
Cable, 1 mile southeast of, 150 feet south of creek, 150 feet east of forks of road, 30 feet north of road; iron post stamped "6459 MSLA"	6,456.
Georgetown, 300 feet west of house, corner of rail fence; iron post stamped "6467 MSLA"	6,464.
Georgetown, 3.2 miles north of, 300 feet west of creek, 0.8 mile south of log stable, 20 feet east of large granite bowlder; on east side of road, in west side of large granite bowlder; bronze tablet stamped "6767 MSLA"	6,764.
Red Lion, junction of road and trail, 150 feet north of road forks, 50 feet southeast of old office, 60 feet southwest of old boarding house, 200 feet west of creek; iron post stamped "7341 MSLA"	7,338.
Red Lion, 1.1 miles west of, 300 feet east of lake, 35 feet north of trail, on summit of pass, in south face of quartz ledge; aluminum tablet stamped "8074 MSLA"	8,072.
Rumsey, 1.8 miles southeast of, 300 feet north of old dam site, east of trail, 25 feet west of creek, in granite bowlder; bronze tablet stamped "7155 MSLA"	7,153.
Rumsey, 200 feet west of mill, 400 feet north of creek, 150 feet east of forks of road, in south side of granite bowlder; bronze tablet stamped "5748 MSLA"	5,746.

Red Lion northwest to Red Lion triangulation station (single spur line).

Red Lion triangulation station, in south side of quartz bowlder; aluminum tablet stamped "8773 MSLA"	8,771.

Point 11.8 miles west of Philipsburg south and east via Rock Creek and Wilma to road forks 1 mile south of Carey ranch (portion of line).

Philipsburg, 11.8 miles west of, 10 feet east of corner of fence at bend of road 1 mile west of road forks, 0.5 mile north of Jenkins's house; iron post stamped "5233 MSLA"	5,230.
Wilma, 2.3 miles west of, 900 feet southeast of creek forks, 150 feet southeast of bridge crossing Rock Creek, 40 feet east of road, in granite bowlder; aluminum tablet stamped "MSLA 5399"	5,396.
Wilma, 2.5 miles southeast of, 600 feet west of Quinlan's house, 50 feet south of road, 40 feet east of creek; bronze tablet stamped "5623 MSLA"	5,620.
Wilma, 6.1 miles east of, 2,000 feet west of log cabin, 100 feet north of road, 2.5 miles west of summit, in top of granite bowlder; bronze tablet stamped "5967 MSLA"	5,964.

Quinlan's ranch south up Meadow Creek (double spur line).

Quinlan's ranch, 3.1 miles southeast of, 380 feet south of gate, 80 feet north of creek, 70 feet east of road in small valley, in quartz bowlder; bronze tablet stamped "5914 MSLA"	5,911.
Quinlan's ranch, 7 miles south of, 4 feet east of road, 12 feet west of Meadow Creek, 40 feet east of ravine, in quartz bowlder; bronze tablet stamped "6596 MSLA"	6,593.

Flint to Royal (double spur line).

Flint, 3.1 miles southeast of, 300 feet north of Maywood's house, 15 feet south of road, in granite bowlder; bronze tablet stamped "5168 MSLA"	5,166.
Princeton, 0.9 mile southeast of, 200 feet south of creek, south of road in granite bowlder; bronze tablet stamped "5571 MSLA"	5,569.
Royal, 2.2 miles southwest of, 300 feet east of creek, 6 feet east of road, in granite bowlder; aluminum tablet stamped "6689 MSLA"	6,687.

	Feet.
Royal, forks of road 60 feet south of log cabin, 150 feet east of log cabin, 300 feet south of abandoned post office, 300 feet north of Royal mill, in granite bowlder; aluminum tablet stamped "7458 MSLA"	7,456.054

Point 1.5 miles west of Wilma south to Moose Lake (double spur line, continued in Sapphire quadrangle).

Dearborn ranch house, 1.1 miles northwest of, 10 feet east of road, 800 feet east of creek, in top of granite bowlder; aluminum tablet stamped "MSLA 5604"	5,602.007
Dearborn ranch house, 1.5 miles south of, 300 feet south of gate, 10 feet west of road, in top of granite bowlder; aluminum tablet stamped "MSLA 5776"	5,774.060

SAPPHIRE QUADRANGLE.

Bench marks on east side of the Sapphire quadrangle on lines completing circuits in the Philipsburg quadrangle.

T. 8 N., R. 15 W., approximately at north line of sec. 32, 30 feet east of road, 0.5 mile north of log house, near Miners Gulch, 1,000 feet east of Willow Creek, 200 feet south of mouth of coulee; iron post stamped "MSLA 5238"	5,235.434
T. 7 N., R. 16 W., south side of sec. 25, 70 feet west of Rock Creek Bridge, at forks of road; iron post stamped "MSLA 4913"	4,910.327
T. 6 N., R. 15 W., north of southwest corner of sec. 8, 100 feet east of gate and road, 10 feet north of creek, 600 feet northeast of log house, south side of fence in surveyed but unused county road; iron post stamped "MSLA 5079"	5,076.287
T. 6 N., R. 15 W., sec. 31, 1.7 miles southwest of Elkhorn (Brown's) ranch house, north entrance of gap, 90 feet west of Rock Creek, 20 feet west of road, east base of rocky cliff, east side of large quartzite bowlder; aluminum tablet stamped "MSLA 5236"	5,233.235

Dearborn ranch house southwest to Moose Lake and sagebrush cabin.

Watson's ranch house, 1.3 miles southeast of, 10 feet east of road, 0.9 mile north of forks of road, granite bowlder; aluminum tablet stamped "MSLA 5887"	5,885.019
Moose Lake, 150 feet northeast of forest ranger's cabin, 20 feet east of road, 150 feet east of lake, in top of granite bowlder; aluminum tablet stamped "MSLA 6034"	6,031.536
At forks of road leading to Moose Lake frog pond, 200 feet east of bridge crossing creek, 600 feet east of John Kinney's cabin; top of bowlder	5,913.14
Kinney cabin, 2.9 miles southwest of, 20 feet west of small road summit east of Copper Creek, in top of bowlder; aluminum tablet stamped "MSLA 6182"	6,179.098
Sage Brush cabin, 100 feet east of, 120 feet northeast of log stable, 6 feet north of road, northwest of Copper Creek, in top of bowlder; aluminum tablet stamped "MSLA 6214"	6,212.436

Point in Eagle Canyon 4.5 miles northwest of Wilma west along west fork of Rock Creek via Sand Basin to Corvallis.[1]

Junction of Ross road and West Fork road, 0.3 mile west of, 600 feet east of log cabin, 2 feet south of road; paint point top of bowlder	5,280.05

[1] This line is not adjusted and closes 1 foot low.

	Fe
Emerine ranch house, 0.7 mile south of, 60 feet north of forks of road, in top of large quartzite bowlder 6 feet east of road; aluminum tablet stamped "MSLA 5432"	5,43
Sapphire boarding house, 1.6 miles west of, 10 feet north of road, 0.5 mile southeast of canyon, in top of bowlder; aluminum tablet stamped "MSLA 5718"	5,71
Sapphire boarding house, 3.6 miles west of, 80 feet west of creek, 100 feet north of West Fork, 2 feet south of trail, in canyon, top of bowlder; aluminum tablet stamped "MSLA 5956"	5,95
West end of canyon, 1.2 miles east of, 180 feet west of creek, south side of trail, in granite bowlder; aluminum tablet stamped "MSLA 6289"	6,28
Log cabin, 0.2 mile west of, 10 feet south of trail, 10 feet north of creek, in granite bowlder; aluminum tablet stamped "MSLA 6438"	6,43
Sand Basin, 10 feet west of trail, west side of basin, at top of granite bowlder; paint point	6,48
Sand Basin, 0.8 mile south of, at forks of creek, 0.1 mile south of old cabin, 60 feet west of creek, east of trail, in top of granite bowlder; aluminum tablet stamped "MSLA 6517"	6,51
Small lake, 100 feet south of, 30 feet south of trail, in top of bowlder; aluminum tablet stamped "MSLA 6727"	6,82
Mud Lake; surface of water	7,01
Divide between West Fork and Skalkaho Creeks, 25 feet south of trail, top of small bowlder; aluminum tablet stamped "7258 MSLA"	7,25
Divide between Skalkaho and Burnt Fork Creeks, 90 feet north of trail, 300 feet west of saddle, at top of outcropping rock ledge; aluminum tablet stamped "MSLA 7853"	7,85
Divide between Skalkaho and Burnt Fork Creeks, 80 feet east of saddle, 20 feet south of trail; nail in base of 12-inch piñon stump	7,934.
Skalkaho Lake; surface of water	7,629.
Skalkaho Lake, 0.2 mile west of, 10 feet south of trail, in top of rock ledge; aluminum tablet stamped "7754 MSLA"	7,752.
Skalkaho Lake, 2.6 miles west of, top of divide between Willow and Gird Creeks, 20 feet north of trail, top of bowlder; aluminum tablet stamped "MSLA 8021"	8,018.
Peyton ranch house, 3.5 miles east of, 100 feet west of saddle, south side of trail, at top of rock ledge; aluminum tablet stamped "MSLA 6881"	6,879.
Peyton ranch house, 0.5 mile south of, on sharp ridge sloping north 4 feet east of trail, in top of rock ledge; aluminum tablet stamped "MSLA 5648"	5,645.

Rock Creek Bridge northwest through canyon to point 8 miles southwest of Zingle.[1]

H. Weyman ranch house, 0.2 mile northwest of, 20 feet south of road, 100 feet south of creek, in east side of sandstone bowlder; aluminum tablet stamped "MSLA" 4789	4,786.
F. Weyman ranch house, 0.3 mile west of, 1 foot south of road; paint point top of bowlder	4,763.
Peterson ranch house, 1.4 miles west of, 10 feet west of road, 4 feet west of rail fence, 600 feet west of log stable, in top of bowlder; aluminum tablet stamped "MSLA 4656"	4,653
Neil McCaulley ranch house, 0.3 mile east of, 1 foot south of road; paint point top of bowlder	4,614
Nigger Ann ranch house, 0.7 mile west of, first hogback on east side of creek, 160 feet northeast of ford 5 of Rock Creek, in ledge; aluminum tablet stamped "MSLA 4532"	4,529

[1] An excessi

	Feet.
Goat ranch house, 0.4 mile northwest of, 4 feet east of road, 100 feet east of creek; paint point top of bowlder	4,462.77
Forest Service cabin, 300 feet south of, 40 feet east of road, west side of rocky ledge; aluminum tablet stamped "MSLA 4437"	4,434.533
Forest Service cabin, 1.8 miles northwest of, 8 feet east of trail, 90 feet east of creek; head of spike at base of leaning fir	4,360.59
Ford 12 of Rock Creek, 60 feet east of, 5 feet east of trail at base of point of ridge in bowlder; aluminum tablet stamped "4325 MSLA"	4,322.596
Ford 17 of Rock Creek, 400 feet north of north side of creek, in creek bed; paint point top of bowlder	4,235.95

TRAPPER PEAK QUADRANGLE.

Fork Bridge up West Fork to Rombo Flats.

Sirra's ranch, 0.25 mile south of, in large pine tree at road intersection; head of nail in bench cut	4,021.62
Trapper Creek Bridge, 0.25 mile north of, in stump west side of road; head of nail in bench cut (old railroad bench mark)	4,133.19
Bakers, south of, in fir tree, south side of road; head of nail in bench cut.	4,220.48
Cameron's ranch, near summit of hill above, at corner of secs. 33 and 34, T. 2 N., and 3 and 4 T. 1 N., R. 21 W.; iron post stamped "4326"	4,374.098
South Fork, mouth of, in fir tree on west side of road near junction of west and south forks; head of nail in bench cut	4,392.97
Rombo Flats, at south corner of secs. 36, T. 1 N., R. 22 W., and sec. 31, T. 1 N., R. 21 W.; iron post stamped "4382"	4,430.582

Darby south along road to Fork Bridge.

Fork bridge, 91.5 feet west of west end of approach to bridge, west of road at junction of East Fork and West Fork roads, in line with south truss of bridge; iron post stamped "3903"	3,951.310

Fork Bridge southeast up East Fork to Sula.

Evelyn, just north of, 174 feet west of the west abutment of first bridge over East Fork; iron post stamped "4033"	4,081.676
T. 1 N., R. 20 W., sec. 2, 70 feet east of schoolhouse and 40 feet from east-west road; iron post stamped "4194"	4,242.584

Fort Logan and Helena 1° Quadrangles.

CLARK, DEERLODGE, JEFFERSON, POWELL, AND SILVERBOW COUNTIES.

The elevations in the following list were determined by primary leveling and accord with values at Butte resulting from a preliminary adjustment made by the Coast and Geodetic Survey in 1911.

Bench marks were established in the city of Butte (in the county courthouse and in the Owsley block) and at Woodville in 1896. Between the Woodville bench mark and Rocker a level line was run in 1899. In order to determine the amount of settling of various points in the city, a number of new bench marks were established in 1904 by carefully checked lines. A comparison of the early records with the later ones shows an apparent settling between 1896 and 1904 of about 1.6 feet at the courthouse and 0.7 foot at the Owsley block, with respect to Woodville, and between 1899 and 1904 of 0.3

foot at the Owsley block, with respect to Rocker. Eleven of the bench marks of this group were redetermined in 1907 by the Coast and Geodetic Survey, with results which agreed within a small range at 7 of them, but which show settling between 1904 and 1907 of about 0.7 foot at the courthouse, 0.4 foot at Owsley block, 0.9 foot at the Government building, and 0.8 foot at the Florence Hotel.

For all bench marks determined by the Coast and Geodetic Survey the values from the preliminary adjustment of 1911 have been adopted. A mean correction has been applied to the other bench marks of the 1904 net in order to refer them to the 1911 datum. The 1904 values have also been given for the marks showing settlement.

The leveling was done in the Fort Logan quadrangle in 1897 by F. B. Whitlock and in 1899 by A. E. Franklin; in the Helena quadrangle in 1897 and 1898 by F. B. Whitlock, in 1899 by A. E. Riedel and A. E. Franklin, in 1900 by J. T. Stewart, in 1904 by R. H. Chapman and G. H. Kendall, and in 1905 by F. E. Fellows.

FORT LOGAN QUADRANGLE.

Boulder Hot Springs southeast to Finn station, thence north along Elkhorn branch of Northern Pacific Ry. to Elkhorn (double-run line).

	Feet.
Finn, 1 mile west of station, 5 miles east of Hot Springs; iron post stamped "4689 BUTTE"	4,691.962
Ivy's ranch, 1 mile north of, 225 feet east of Elkhorn Creek, 450 feet northeast of Northern Pacific Ry. bridge 16, west side of highway; iron post stamped "5206 BUTTE"	5,209.537
Queen's siding, 90 feet east of, 9 feet east of highway; iron post stamped "5694 BUTTE"	5,697.260
Elkhorn, in front base of Northern Pacific Ry. watertank; aluminum tablet stamped "6571 BUTTE"	6,574.727
Elkhorn, at north corner of oil house, New Elkhorn Mining Co.'s bench mark; iron pipe set in ground	6,619.612

Hartwell northeast along Great Northern Ry. to Montana City.

Alhambra, in front of station; top of rail	4,270
Clancy, at northeast corner of H. M. Hill's garden fence; iron post stamped "BUTTE 4247"	4,250.125
Rhorbaugh; in front of station; top of rail	4,119.8
Montana City, 60 feet in rear of Great Northern R'y section house; iron post stamped "BUTTE 4064"	4,067.135

Montana City north along Great Northern Ry. to East Helena.

East Helena, opposite smelter; nail in head block in track	3,927.8

East Helena west along Great Northern Ry. to Helena.

Helena, 2.2 miles east of, in the northeast corner of old halfway house between Helena and East Helena; bronze tablet stamped "BUTTE 3934"	3,937.286

Point 6 miles north of Helena east to Gamer triangulation station, thence north and east to Pugh's ranch.

	Feet.
Helena, 8.75 miles northeast of, Gamer triangulation station; copper bolt in granite post	3,665.190
Helena, 9 miles northeast of, 0.25 mile north of Gamer triangulation station, 50 feet in front of G. Reed's ranch house; iron post stamped "BUTTE 3666"	3,668.844
T. 11 N., R. 3 W., NW. ¼ sec. 23, corner of G. W. Pugh's ranch; iron post stamped "BUTTE 3658"	3,661.708

Helena northeast along highway via Cram's ranch to Pugh's ranch.

Helena, 2.5 miles northeast of, near Wallace Breck's ranch, in Prickly Pear Valley, at intersection of Boulevard and Stubbs Ferry roads; iron post stamped "BUTTE 3738"	3,741.157
Helena, 4 miles northeast of, in southwest corner of Valley schoolhouse; bronze tablet stamped "BUTTE 3738"	3,740.893
Helena, 5 miles northeast of, south side of gate leading to H. L. Cram's ranch; iron post stamped "BUTTE 3715"	3,717.735
Helena, 7.5 miles northeast of, in front of D. Beach's ranch; iron post stamped "3660"	3,662.761

Pugh's ranch east 2.5 miles, thence south 10.5 miles to East Helena.

East Helena, 8 miles north of, 1 mile north of Geary ranch, 30 feet east of bridge over Prickly Pear Creek at mouth of canyon; iron post stamped "BUTTE 3634" [1]	3,636.839
East Helena, 6 miles north of, at southeast corner of Harmony schoolhouse; iron post stamped "BUTTE 3722"	3,724.868
East Helena, 2.5 miles northeast of, on Canyon Ferry road at Gratten's ranch; iron post stamped "BUTTE 3784"	3,786.153
East Helena, 2 miles east of, sec. 29, T. 10 N., R. 2 W., 100 feet in front of Joseph Kenck's ranch house; iron post stamped "BUTTE 3858"	3,860.841
East Helena, in southeast corner of schoolhouse; bronze tablet stamped "BUTTE 3886"	3,888.811
East Helena, 1.5 miles south of, in southwest corner of barn at Childs ranch; bronze tablet stamped "BUTTE 3956"	3,958.860
East Helena, 1 mile west of, east end of base line, in stone 9 inches square; bronze tablet stamped "BUTTE 3921"	3,924.246

Montana City west 3 miles (on circuit to Helena).

Montana City, 3 miles west of, in 4 by 4 by 6 foot granite bowlder, 60 feet south of reservoir at head of Clarke's Creek, 0.25 mile east of Cutter's ranch, at forks of road leading to Clancy and Helena, 30 feet from lone fir tree; bronze tablet stamped "BUTTE 4589"	4,591.866

Kleinsmidt's ranch northeast to Missouri River.

Missouri River, south bank, just north of mouth of Prickly Pear Creek; iron post stamped "BUTTE 3600"	3,603.067
Missouri River at El Dorado Bar, north bank; top of cast-iron cap of Missouri River Commission bench mark 21. (Uncorrected Missouri River Commission value, 3,627.840 feet)	3,631.821

[1] C. H. Jordan reports (Feb. 27, 1911) that this bench mark will soon be under Hauser Lake.

HELENA 1° QUADRANGLE.

Butte and vicinity; Florence Hotel via courthouse and North Main Street to Walkerville triangulation station.

	Feet.
Florence Hotel, East Broadway and Thornton Avenue, in coping under sill of second window west of main entrance, 18 inches below sill and 18 inches above sidewalk; aluminum tablet stamped "5716 RHC 04":	
Elevation by leveling of 1904	5,718.590
Elevation by Coast and Geodetic Survey in 1907	5,717.804
Owsley Block, northeast corner Main and Park streets, in corner stone facing Park Street, 1.5 feet above sidewalk; copper bolt stamped "5712":	
Elevation by leveling of 1904	5,715.429
Elevation by Coast and Geodetic Survey in 1907 (apparent settlement 0.4 foot)	5,715.015
Courthouse, West Granite Street, in wall facing south, 2 feet above turf, west of entrance; bronze tablet stamped "5767 R.H.C. 04":	
Elevation by leveling of 1904	5,769.485
Elevation by Coast and Geodetic Survey in 1907 (apparent settlement 0.7 foot)	5,768.755
United States Government Building, corner of Main Street, in block, corner of coping, northwest corner of building, 10 feet northwest of; aluminum tablet stamped "5811 R.H.C. 04":	
Elevation by leveling of 1904	5,808.597
Elevation by Coast and Geodetic Survey in 1907 (apparent settlement of 0.866 foot)	5,807.731
Government Building, northeast corner of, top of coping; corner of wall (elevation by leveling of 1904)	[1]5,804.564
Government Building, southwest corner of; sidewalk (elevation by leveling of 1904)	[1]5,794.266
Government Building, southeast corner of, close to wall, north of gutter; cement shoulder (elevation by leveling of 1904)	[1]5,793.075
Government Building, northwest corner of north balustrade; sidewalk (elevation by leveling of 1904)	[1]5,803.739
Government Building, southwest corner of south balustrade; sidewalk (elevation by leveling of 1904)	[1]5,798.437
Centerville, Blaine public school, North Main Street, in sill of first window north of entrance; aluminum tablet stamped "R.H.C. 04"	6,150.933
Walkerville, Bryan's store on corner Main and Daly streets, in sill of first window north of entrance; aluminum tablet stamped "R.H.C. 04"	6,186.840
Walkerville, 100 yards east of Jackson School (closed), 20 yards north from road east from schoolhouse to Valdmere Hoist, in granite bowlder; aluminum tablet stamped "R.H.C. 04"	6,361.716
Walkerville, 0.25 mile north of brick school house, at Walkerville triangulation station, 0.5 mile northeast of shaft house at Alice mine, 25 feet north of prospect hole on First Stake claim, 250 feet east of Butte-Stringtown road, in granite bowlder; aluminum tablet stamped "R.H.C. 04"	6,467.432

Butte and vicinity; Owsley Block west to McKinley School.

Lincoln School, West Broadway, in balustrade south of steps; aluminum tablet stamped "5714 R.H.C. 04"	5,717.393
McKinley School, West Park Street, west of Excelsior Street, in coping east of entrance close to iron grill decoration; aluminum tablet stamped "5702 R.H.C. 04"	5,705.350

[1] Value not determined in 1907.

Butte and vicinity; Owsley Block south via Butte Reduction Works to Butte Butchering Co. plant.

	Feet.
Colorado Street School, in top of block at foot of balustrade on north side of steps; aluminum tablet stamped "5631 R.H.C. 04"	[1] 5,633.552
Webster School, on West Aluminum Street, one-half block west of Montana Street, in top of block at foot of east balustrade; aluminum tablet stamped "5563 R.H.C. 04"	[1] 5,566.294
Butte Reduction Works, inside fence around smelting plant, 35 feet north of east gate, 70 feet south of boiler house on electric light plant, 40 feet west of line of telephone poles on west side of Montana Street, in granite block 6 by 8 by 36 inches, set 24 inches in ground and mounded to top; aluminum tablet stamped "5441 R.H.C. 04"	[1] 5,444.116
Timber Butte, 1 mile north of, 0.5 mile southeast of end of Cemetery trolley line at south end of Montana Street, 10 feet east of wood road from Butte Butchering Co. plant, 46 feet west of bowlder upon which lies a weathered bowlder resembling an alligator, set in flat bowlder; aluminum tablet stamped "5535 R.H.C.04"	5,538.368

Butte and vicinity; Florence Hotel east to B. & B. smelter, thence southwest via South Butte to Butte Reduction Works.

Braund House, Talbot Avenue, in sill of smaller door on Talbot Avenue front; bronze tablet stamped "R.H.C. 04"	[1] 5,568.821
South Butte, 75 yards south of south line of East Front Street, 73 yards west of west end of bridge where trolley line passes under Northern Pacific Ry. track, north of railway track, in 6 by 8 by 36 inch granite block, 30 inches in ground, mounded to top; aluminum tablet stamped "5485 R.H.C. 04"	[1] 5,488.408

B. & B. smelter east along highway and up Park Canyon northeast to Woodville Summit (Elk Park Pass).

Pittsmont smelter, 0.5 mile north of, north side of road up Park Canyon, in line with poles of power line, 185 yards east of crossing with track connecting Farrell shafts 2 and 3, 10 feet east of pole 3017; iron post stamped "5613 R.H.C. 04"	5,615.527
Park Canyon, 100 yards west of Monitor tunnel, point of rocky ridge, 50 yards north of road, 10 yards east of bottom of small gulch in rock ledge; bronze tablet stamped "5968 R.H.C. 04"	5,971.179
Elk Park Pass (Woodville Summit), about 80 feet south of highest point of pass, east of railroad track, 40 feet east of ditch, 10 feet west of road from Butte, in granite bowlder; copper bolt stamped "6376"	6,379.268
Elk Park Pass (Woodville Summit), 0.5 mile east of, 25 feet south of wood road at point of ridge, in granite bowlder; bronze tablet stamped "6413 R.H.C. 04"	6,415.580

B. & B. smelter along highway and railroad to Mountain Junction, thence southeast to Woodville Summit.

Meaderville, corner of Main and Colusa streets, 3.5 feet north of northeast corner of Methodist Episcopal Church; iron post stamped "5555 R. H. C. 04"	5,557.788
Meaderville, 0.25 mile west of, 50 feet east of Great Northern Ry. track, 30 feet north of road near B. & M. settling tanks, north of West Colusa mine; iron post stamped "5678 R. H. C. 04"	5,680.569
Mountain Junction, 300 paces southwest of, 12 feet west of Great Northern Ry. track, in granite bowlder; tablet stamped "5882 R. H. C. 04"	5,885.132

[1] As redetermined by Coast and Geodetic Survey in 1907.

	Feet.
Mountain Junction, 1 mile southeast of, 25 paces east of track, 50 paces south of sign (J. 1 M.) in granite bowlder; bronze tablet stamped "6013 R. H. C. 04"	6,015.495
Tunnel 10, 450 feet east of east end of, 50 feet north of track about 20 feet above it, in solid ledge of rock; bronze tablet stamped "6233 R. H. C. 04"	6,236.324

Woodville northeast along highway via Elk Park to Bernice.

Woodville, 2 miles east of, 3 feet west of old cabin east of road from Woodville to Jack Clinton's placer mine; iron post stamped "6509"	6,512.677
Woodville, 3 miles north of, near flagstaff in front of Gagner's house on west side of road between Woodville and Elk Park; iron post stamped "6363"	6,366.493
Elk Park, 4 miles south of station, 75 feet from Great Northern Ry. track at point where road from Elk Park to Butte crosses (first crossing south of Elk Park); iron post stamped "6268"	6,271.367
Elk Park, north side of Great Northern Ry. track between station and water tank; iron post stamped "6229"	6,232.578
Bison Creek canyon, on last bent at north end of Great Northern Ry. bridge 140; nail	6,151.9
Bison Creek canyon, on cap of first bent at south end of Great Northern Ry. bridge 135; nail	6,062.3
Lake Wilder, at station; platform	5,737.5
Lake Wilder, 30 feet in front of pavilion, on road between Basin and Butte, west of Bison Creek; iron post stamped "5650"	5,653.217
Bernice, in front of station; top of rail	5,541.4

Bernice west and south up Lowland Creek and over divide to Butte.[1]

Calvin, Northern Pacific Ry. station, in dooryard of Calvin's ranch, 25 feet southeast of house; iron post stamped "5555"	5,558.635
Bernice, 7 miles west of, in bunk house, near old sawmill on east side of Lowland Creek; nail	5,915.30
Bernice, 7 miles southwest of, near northeast corner of Lavatelle's house on west side of Lowland Creek and west of road to Butte; iron post stamped "6008"	6,011.250
Bernice, 10 miles southwest of, in flagpole, near office of Flume Co., on Lowland Creek; nail	6,059.9
Walkerville, 10 miles north of, 60 feet south of forks of road and 6 feet from road to Walkerville, about 1 mile north of J. Edward's house; iron post stamped "6724"	6,727.505

Bernice east along Great Northern Ry. to Boulder (double-run line)

Basin, 1.8 miles west of, on cap of first bent at south end of Great Northern Ry. bridge 127; nail	5,413.34
Basin, in front of Northern Pacific Ry. station; top of rail	5,348.5
Basin, Dennis Driscoll & Co.'s store, north face of corner stone at northwest corner of building, about 18 inches above sidewalk; bronze tablet stamped "5351"	5,354.810
Basin, in front of Great Northern Ry. station; top of rail	5,337.3
Basin, 2 miles east of, in sill of middle bent of Great Northern Ry. bridge 121, crossing Northern Pacific Ry. track; nail	5,180.23
Boulder, in stone foundation near northwest corner of public school building south of courthouse; bronze tablet stamped "4904"	4,907.328

[1] The error distributed in this line is excessive.

Regiment placer mine west to mouth of Cottonwood Creek.

	Feet.
Lowland Creek, mouth of, at forks of Basin-Deerlodge and Basin-Butte (via Lowland Creek) roads, near Gopher mine; iron post stamped "5804".	5,807.318
Cottonwood Creek, mouth of, 150 feet west of bridge over Cottonwood Creek near its junction with the Boulder River, near Basin and Deerlodge road; iron post stamped "6045.5"	6,048.827

At Thunderbolt Mountain (single spur line north of Thunderbolt Creek).

Thunderbolt Mountain, 1.25 miles west of Continental Divide triangulation station, 3 feet south of hunter's cabin in park, near head of Cottonwood Creek, 5 miles north of bridge over Cottonwood Creek near its mouth on Boulder River; iron post stamped "7302"	7,305.155

Boulder south along Whitehall road to sec. 21, T. 3 N., R. 4 W. (double-run line).

Boulder Hot Springs, 0.7 mile west of, on Whitehall road, at corner of fence south side of road to hot springs in yard at G. A. Douglas's place; iron post stamped "4821"	4,824.378
Boulder Hot Springs, in front of Northern Pacific Ry. station; top of rail (1899)	4,807.3
Boulder, divide 6 miles south of, near Whitehall road, in large granite bowlder about 25 feet east of road, on divide between waters of Little Boulder River and Whitetail Creek; bronze plate stamped "5724"	5,727.523
Boulder, 7 miles south of, on east side of road from Boulder to Whitehall; nail on corner of Eberhart's house	5,295.42
Boulder, 8.5 miles south of, at fork of Whitehall and Boulder road and road to State mine; iron post stamped "5210"	5,213.236
Whitehall, 13 miles north of, in garden 40 feet from door of Marsh's house on west side of road from Whitehall to Boulder; iron post stamped "4830"	4,833.503
Whitehall, 10 miles north of, in sec. 21, T. 3 N., R. 4 W., in yard, 10 feet from J. E. Faulkner's house, on west side of road from Whitehall to Boulder; iron post stamped "4711"	4,714.782

Douglas's ranch, near Boulder, southwest up Little Boulder River 7 miles (double line).

Boulder, 7 miles southwest of, on granite bowlder 6 by 6 by 7 feet, 5 feet from center of road (north side) up Little Boulder River; bronze tablet stamped "5731"	5,734.220

Point on Boulder road west via circuit to State mine.

Boulder, 10 miles southwest of, at State mine, in large granite bowlder 150 feet southwest of hoist and 15 feet east of middle of road; bronze tablet stamped "6945"	6,948.671

Point on Boulder road west over divide into Little Whitetail Park (single spur line).

Little Whitetail Park, 2 miles northwest of E. W. Crosby's house, in 40 by 20 foot rock 200 feet south of miner's cabin on east side of creek; x cut	5,723.973
Little Whitetail Park, 150 feet south of E. W. Crosby's house, in granite bowlder 1 by 6 by 6 feet; bronze tablet stamped "5744"	5,747.130

Boulder northeast along Helena and Boulder Valley branch of Northern Pacific Ry. to Hartwell.

	Feet
Boulder, 4 miles north of, southeast corner of Amazon smelter; iron post 1 foot out of ground stamped "BUTTE 5097"	5,100
Summit of divide between Boulder and Jefferson, 20 feet to right of road over tunnel; iron post stamped "BUTTE 5727"	5,730
Jefferson, the southwest corner of post-office building, 18 inches above sidewalk; bronze tablet stamped "BUTTE 4554"	4,557
Hartwell, at station; top of rail at road crossing	4,376

Helena southwest along Helena and Red Mountain branch of Northern Pacific Ry. to Rimini.

Helena, 3.5 miles west of, at northwest corner of Broadwater natatorium; iron post stamped "BUTTE 3962"	3,964.
Rimini, 9 miles northeast of, 20 feet to left of road to Rimini and 150 feet west of road crossing about 6 miles west of Helena; iron post stamped "BUTTE 4217"	4,219.
Rimini, 30 feet from north end of railroad station; iron post stamped "BUTTE 5190"	5,192.

Rimini south along public road via Pauper's Dream and Buckeye mines to Basin.

Rimini, 3.7 miles south of, at forks of roads leading to Pauper's Dream and Ontario mines; iron post stamped "BUTTE 6218"	6,220.
Rimini, 6.5 miles south of, on divide opposite Pauper's Dream mine, 6 feet from road and 150 feet from mine; iron post stamped "BUTTE 7615"	7,617.
Rimini, 9.5 miles southwest of, at northeast corner of office at Buckeye mine; iron post stamped "BUTTE 7133"	7,135.
Basin, 8 miles northwest of, in garden, 30 feet in front of H. Winter's house; iron post stamped "BUTTE 6639"	6,641.
Basin, 6.8 miles northwest of, 30 feet north of bridge over Jacks Creek, left side of road from Basin to H. Winter's camp, 3 miles south of Winter's camp; iron post stamped "BUTTE 6273"	6,275.
Basin, 5.8 miles northwest of, in granite bowlder 40 by 20 feet, 300 feet south of Penn placer, on right side of road; bronze tablet stamped "BUTTE 6188"	6,191.

Basin northeast along road via Cataract Creek to Jefferson.

Basin, 7 miles northeast of, in foundation on east side of Eva May mill; bronze tablet stamped "BUTTE 6545"	6,548.
Wickes, 5 miles west of, top of divide between Wickes and Eva May mine; iron post stamped "BUTTE 7215"	7,218.
Wickes, south end of Northern Pacific Ry. station; iron post stamped "BUTTE 5162"	5,165.
Corbin, 3 miles north of Wickes, southeast corner of William Johnson's saloon, opposite Corbin Hotel; iron post stamped "BUTTE 4766"	4,769.

Wickes north and northeast along Gregory and Clancy Creek public road to Clancy.

Gregory, 3 miles north of Wickes, at southeast corner of schoolhouse; iron post stamped "BUTTE 5450"	5,452.
Gregory, 2 miles north of, in granite bowlder 4 feet square, 500 feet north of Clark's ranch and 200 feet north of road leading up Quartz Gulch, 10 feet to left of road to Clancy; bronze tablet stamped "BUTTE 5048"	5,051.

	Feet.
Clancy, 5 miles southwest of, southeast corner of Lehman's ranch house; iron post stamped "BUTTE 4677"	4,680.129
Clancy, about 2 miles southwest of, 40 feet from gate leading to Strobel's ranch, in granite bowlder 8 by 4 feet; bronze tablet stamped "BUTTE 4408"	4,411.175

Pauper's Dream mine along road west to Monarch mine, thence north to Elliston public road.

Ontario mine, 10 feet southwest of superintendent's house; iron post stamped "BUTTE 7032"	7,034.287
Old Republic mill site, 1.5 miles west of Ontario mine and 2 miles east of Monarch mine, 150 feet east of bridge crossing Little Blackfoot River; iron post stamped "BUTTE 6308"	6,310.397
Monarch mine, northwest corner of cookhouse; iron post stamped "BUTTE 7243"	7,245.274
Elliston, 11 miles south of, 1,400 feet west of old Hidden Treasure mill, 350 feet west of bridge over creek, 10 feet to left of road to Elliston; iron post stamped "BUTTE 5612"	5,614.374
Elliston, 5 miles southeast of, 0.5 mile from fork of road leading up Little Blackfoot, 20 feet from road leading from Elliston to Ontario mine, 60 feet in front of Felix Senecal's ranch house; iron post stamped "BUTTE 5283"	5,285.454

Senecal ranch south to Ontario mine.

Telegraph mine, near, at fork of road; cross on big granite rock	6,242.94

Helena north along Montana Avenue 7 miles.

Helena, 2 miles north of, in wall, south side of entrance to Orphans' Home; bronze tablet stamped "BUTTE 3843"	3,845.756
Helena, 4.8 miles north of, in southwest corner of university building; bronze tablet stamped "BUTTE 3724"	3,726.989
T. 11 N., R. 3 W., corner of secs. 19, 20, 29, and 30; stone monument	3,725.55

Helena south and east via Unionville to Montana City.

Helena, 0.5 mile west of Northern Pacific Railway station, west end of base line, in stone 9 inches square; bronze tablet stamped "BUTTE 3957.5"	3,960.607
Helena, in wall right side of west entrance to Armory Hall; bronze tablet stamped "BUTTE 4013"	4,015.940
Helena, granite sill of Brown Block (Northern Pacific Ry. bench mark; railway elevation, 4121.6)	4,135.59
Helena, courthouse, left side of north entrance, 2 feet above ground; bronze tablet stamped "BUTTE 4157"	4,160.005
Helena, city hall, left side of engine-house door; bronze tablet stamped "BUTTE 4108"	4,110.992
Park City, 300 feet north of Henry's mill, at forks of roads to Unionville, Helena, and Nelson Gulch; iron post stamped "BUTTE 4916"	4,919.038
Unionville, 0.5 mile west of, at summit of divide; iron post stamped "BUTTE 5053"	5,055.930
Unionville, northeast corner of Constance's garden fence; iron post stamped "BUTTE 4911"	4,913.888
Unionville, 1.5 miles east of, 50 feet from northwest corner of Hale's reservoir at head of Dry Gulch, 10 feet to left of road to Unionville; iron post stamped "4946"	4,948.936

	Feet.
Unionville, 1.8 miles east of, in 3 by 3 foot granite rock 50 feet to left of road on divide between Tucker Gulch and Dry Creek; bronze tablet stamped "BUTTE 5119"	5,121.822
Unionville, 3.5 miles east of, in granite bowlder 3 by 4 by 2 feet, on top of divide between Tucker Gulch and Indian Creek; bronze tablet stamped "BUTTE 5258"	5,260.898

Northeast corner of sec. 19, T. 11 N., R. 3 W., west to Silver Creek, thence south over divide to Sevenmile Creek, thence southeast to Broadwater Natatorium.

Helena, 8 miles north of, at northeast corner of sec. 19, T. 11 N., R. 3 W., on Montana Avenue; iron post stamped "BUTTE 3749"	3,751.884
T. 11 N., R. 4 W., southwest corner of sec. 13, southeast corner of schoolhouse; iron post stamped "BUTTE 3854"	3,856.867
Helena, 10 miles northwest of, at side of road to Silver City, 20 feet west of bridge crossing Silver Creek; iron post stamped "BUTTE 3998"	4,000.805
Helena, 8.5 miles northwest of, on summit of divide between Silver Creek and Sevenmile Creek; iron post stamped "BUTTE 4454"	4,456.822
Helena, 7 miles northwest of, opposite old saloon near Sevenmile Creek, on Marysville road; iron post stamped "4088"	4,090.703
Fort Harrison, in administration building; bronze tablet stamped "BUTTE 4004"	4,006.940

Silver west along wagon road to Marysville, thence south along Northern Pacific Ry. to Sampson's siding.

Silver, 0.25 mile west of, 45 feet north of highway to Marysville via Race Track, 150 feet north of abandoned railroad fill; iron post stamped "4344 BUTTE"	4,346.848
Cyanide plant, 115 feet east of, south of road; iron post stamped "4684 BUTTE"	4,687.238
Marysville, in front of Montana Mining Co.'s office; iron post stamped "5364 BUTTE"	5,366.704
Marysville, 3.2 miles south of, on Continental Divide between Sawmill and American gulches, 30 feet west of road; iron post stamped "6539 BUTTE"	6,542.233
Dogtown, 1,500 feet north of sawmill site, 75 feet north of highest placer ditch, 30 feet east of unused highway to Blossburg; iron post stamped "5956 BUTTE"	5,958.693
Blossburg, 0.7 mile northwest of station, on west line of highway, 1,500 feet north of Northern Pacific Railway crossing at spur to brickyard; iron post stamped "5611 BUTTE"	5,613.568

Silver via Prickly Pear Valley and Proctor's and Sanford's ranches to Marysville.

Trinity, 0.5 mile east of, 60 feet west of county highway, 2 miles northwest of Silver station on Great Northern Railway; iron post stamped "4374 BUTTE"	4,376.690
Canyon Creek road, at junction with Little Prickly Pear Creek road, 100 feet west of Canyon Creek road and 30 feet north of Little Prickly Pear Creek road; iron post stamped "4377 BUTTE"	4,380.249
Sanford's ranch, 0.33 mile southwest of house; 90 feet southwest of gateway of drive to house, 45 feet south of highway; iron post stamped "4623 BUTTE"	4,626.334
Deer Creek, 250 feet northeast of crossing of Big Ox highway over, 1 mile south of Big Ox stamp mill, east of highway, in face of ledge; aluminum tablet stamped "4987"	4,989.657

Sampson's siding, Northern Pacific Ry., southeast along highway to Tenmile Creek via McDonald Pass.

	Feet.
McDonald Pass, 2.5 miles west of summit, 800 feet west of abandoned sawmill, 25 feet north of road on small ridge; iron post stamped "5650 BUTTE"	5,652.846
McDonald Pass, summit of Continental Divide, 40 feet south of road, in flat granite rock 10 by 8 feet and 18 inches high; aluminum tablet stamped "6334 BUTTE"	6,336.999
Old Toll Gate, southeast corner of, on north side of road; iron post stamped "4812 BUTTE"	4,814.910

Sampson's siding west along Northern Pacific Ry. to Elliston.

Sampson's siding, 100 feet southeast of milepost 26; iron post stamped "5235 BUTTE"	5,238.321
Elliston, 75 feet northeast of station, 45 feet north of track; iron post stamped "5043 BUTTE"	5,046.418

Elliston west along Northern Pacific Ry. to Garrison schoolhouse (run twice).

Avon, 150 feet northwest of station, at fence corner; iron post stamped "4687 BUTTE"	4,690.119
Bradley siding, 1 mile east of, 10 yards north of track on south side of highway at road crossing; iron post stamped "4566"	4,569.814
Avon, 8.6 miles west of, at road crossing, 10 yards north of railroad, east side of highway; iron post stamped "4454"	4,457.622

Haskell east along Northern Pacific Ry. to Garrison (run twice).

Haskell, 3 miles east of, opposite milepost "62 HLNA" 60 feet south of track 2 feet south of fence in field; iron post stamped "4141 MSLA"	4,138.934
Gold Creek, 1,500 feet east of station, 400 feet southeast of section house, 100 feet south of track, 2 feet south of fence; iron post stamped "4198 MSLA"	4,195.861
Gold Creek, 3.5 miles east of, 100 feet south of milepost "56 HLNA"; iron post stamped "4243 MSLA"	4,240.865
Garrison, 2.5 miles west of, opposite milepost "53 HLNA," 120 feet north of track in field, 2 feet north of fence; iron post stamped "4293 MSLA"	4,290.800
Garrison, 200 feet south of schoolhouse, 15 feet north of highway; iron post stamped "4331 BUTTE"	4,335.363

Avon northwest along highway to Helmville.

Avon, 3.3 miles northwest of, beside fence east of road at top of small ridge; iron post stamped "4823 BUTTE"	4,826.196
Avon, 6.7 miles northwest of, top of divide at head of Nevada Gulch, 25 feet east of road; iron post stamped "5108 BUTTE"	5,111.075
Avon, 10 miles northwest of, 1.5 miles northeast of P. & P. ranch at side of fence east of road; iron post stamped "4872 BUTTE"	4,875.071
Washington Gulch, 1 mile south of, west side of road at angle of road; iron post stamped "4836 BUTTE"	4,838.991
Washington Gulch, 100 feet west of post office, side of fence west of road; iron post stamped "4811 BUTTE"	4,814.002
Washington Gulch, 2.5 miles west of, 0.3 mile west of Murphy's ranch, beside fence north of road; iron post stamped "4713 BUTTE"	4,715.861
Washington Gulch, 5.1 miles northwest of, 150 feet northeast of Fitzpatrick's lower ranch, near fence, south of road; iron post stamped "4599 BUTTE"	4,601.974

	Feet.
Helmville, 6.8 miles southeast of, 800 feet southwest of Bierman's ranch, 150 feet east of small creek, on ridge near fence, north of road; iron post stamped "4570 BUTTE"	4,572.925
Helmville, 3.5 miles southeast of, 20 feet west of Helborn's yard gate, north side of road; iron post stamped "4426 BUTTE"	4,428.693
Helmville, 100 feet north of post office and Marcum & Lennon's store, near fence, north of road; iron post stamped "4303 BUTTE"	4,305.583

Blackfoot River south to Helmville.

Lynn's ranch, 0.2 mile north of, 0.3 mile north of bridge over Blackfoot River, 200 feet east of road, 50 feet south of fence corner; iron post stamped "4268 MSLA"	4,266.182
Blair's ranch, 0.5 mile southwest of, 2.7 miles north of Helmville, south side of road, 50 feet west of swing gate; iron post	4,322.345

Helmville northeast along Big Blackfoot River to point 3.5 miles north of mouth of Landers Fork.

Smith's ranch, 300 feet northwest of, near fence, west of road; iron post stamped "4257 BUTTE"	4,259.541
Smith's ranch, 3.7 miles northeast of, 0.6 mile northeast of sawmill, mouth of Big Blackfoot River canyon, 5 feet west of southwest corner of approach to steel bridge; iron post stamped "4306 BUTTE"	4,308.678
Kershaw's ranch, 500 feet northeast of, side of fence, southwest side of road; iron post stamped "4365 BUTTE"	4,367.448
Mooso's ranch, 800 feet southeast of, at corner of secs. 23, 24, 25, and 26, T. 14 N., R. 10 W., 50 feet west of road; iron post stamped "4405 BUTTE"	4,407.516
Lincoln Creek, 400 feet southwest of mouth of, at easternmost outcrop of rock at head of Big Blackfoot River canyon, 25 feet west of road, in flat rock, 4 by 4 feet; bronze tablet stamped "4477 BUTTE"	4,479.398
Lincoln, 275 feet south of post office, west side of road near fence; iron post stamped "4533 BUTTE"	4,535.459
Lincoln, 3 miles northeast of, 3 miles southwest of mouth of Landers Fork, in small park 25 feet southeast of road; iron post stamped "4638 BUTTE"	4,640.417
Lincoln, 6 miles northeast of, 1,000 feet east of Landers Fork near its mouth, 25 feet north of road; iron post stamped "4751 BUTTE"	4,753.391
Landers Fork, 3.5 miles north of mouth of, 400 feet east of creek, 25 feet west of road where Indian trail leaves Creek Valley; iron post stamped "4953 BUTTE"	4,955.416

Garrison south along Northern Pacific Ry. to Race Track (mean of two lines).

Hanson's ranch, 250 feet south of house, 0.1 mile south of Northern Pacific Ry., 25 feet north of highway, 3.5 miles southeast of Garrison station; iron post stamped "4402 BUTTE"	4,406.021
Moro's ranch, 0.25 mile northeast of house, on east side of highway, 3 miles north of Deerlodge; iron post stamped "4451 BUTTE"	4,455.587
Deerlodge, 125 feet east of Northern Pacific Ry. station, south side of highway; iron post stamped "4516 BUTTE"	4,520.033
McDaniel's ranch, 0.2 mile southwest of house, west side of highway; iron post stamped "4571 BUTTE"	4,582.600
Race Track schoolhouse, 90 feet northeast of, at northeast corner of schoolyard fence, west side of highway; iron post stamped "4654 BUTTE"	4,665.622
Race Track, near station, 60 feet north of crossing, 30 feet east of tracks, north side of highway, 300 feet east of railroad milepost 20; iron post stamped "4687 BUTTE"	4,697.849

Race Track south along Northern Pacific Ry. to Rocker.[1]

	Feet.
Milepost 23, 0.1 mile southeast of, 30 feet east of railway south of private road crossing to old John Fifer estate; iron post stamped "4732 BUTTE"....	4,743.498
Warm Springs, 300 feet southeast of station, 15 feet east of tracks of Northern Pacific Ry., east side of highway at crossing; iron post stamped "4809 BUTTE".....	4,819.826
Stuart, 200 feet southwest of station, 75 feet west of tracks, west side of highway; iron post stamped "4984 BUTTE".....	4,995.211
Milepost 30, 0.1 mile northwest of; 30 feet east of rails at private road crossing to James R. Purdee's ranch; iron post stamped "4880 BUTTE"	4,890.261
Gregson, 150 feet east of crossing at station, south side of highway; iron post stamped "5085 BUTTE".....	5,095.674
Miles's ranch, 0.1 mile east of house, 300 feet south of railroad crossing, 3 miles west of Silverbow; iron post stamped "5267".....	5,277.920
Silverbow, 180 feet south of station, junction of Oregon Short Line R. R. and Northern Pacific Ry., 165 feet south of Oregon Short Line R. R. track, 66 feet west of county road; iron post stamped "5327 BUTTE" (redetermined in 1907 by Coast and Geodetic Survey precise levels).....	5,337.473
Rocker, 0.3 mile southeast of water tank, on Butte, Anaconda & Pacific Ry., in fork of road, south of Silverbow Creek, 150 feet south of Northern Pacific Ry., north side of highway; iron post stamped "5388 BUTTE" (redetermined in 1907 by Coast and Geodetic Survey precise levels) ...	5,398.692

Deerlodge southeast along highway to Lockhart and Thunderbolt Creek.

Deerlodge, 3.4 miles southeast of, south side of road; iron post stamped "4918 BUTTE".....	4,922.320
Deerlodge, 6.9 miles southeast of; south side of road; iron post stamped "5383 BUTTE".....	5,387.310
Deerlodge, 10.5 miles southeast of, near Brown's ore camp, 150 feet southeast of road fork, 20 feet north of road; iron post stamped "5940 BUTTE".	5,944.133
Gospel Mountain, at intersection of roads on northwest side, on west side of road; nail in root of 24-inch pine tree.....	6,495.419
Champion, 0.5 mile east of, top of Continental Divide, 50 feet east of deserted cabin at forks of road; iron post stamped "7012 BUTTE".....	7,016.196
Lockhart's ranch, 0.3 mile northwest of, south side of road at intersection of roads from Champion, Calvin, and Lockhart's house; iron post stamped "6447 BUTTE".....	6,451.088

Warm Springs west along highway to point 3.5 miles west of Anaconda.

Warm Springs, 3 miles southwest of, 60 feet south of creek, 800 feet east of Green's residence, north side of road; iron post stamped "4927 MSLA"..	4,924.519
Warm Springs, 5.5 miles southwest of, 200 feet east of small white house, west side of road, near forks of road; iron post stamped "5055 MSLA"..	5,052.512
Anaconda, 2.8 miles east of, 60 feet north of wagon road, east end of base line, at forks of road, iron post stamped "5124 MSLA".....	5,121.545
Anaconda, Montana Hotel, in granite base of left pillar at entrance; aluminum tablet stamped "5278 MSLA".....	5,275.269
Anaconda, 3.5 miles northwest of, 1,000 feet north of house, at mouth of coulee, south side of road; iron post stamped "5463 MSLA"	5,460.555

[1] An excessive error has been distributed in this line.

Granite Peak and Red Lodge Quadrangles.

CARBON COUNTY.

The connection with sea level datum for the elevations in the following list is approximate only.

The elevations in the Granite Peak quadrangle are from unchecked lines, and are therefore unreliable.

The leveling was done in the Red Lodge quadrangle by E. W. Glafcke in 1896, and in the Granite Peak quadrangle by Orr Meredith in 1909.

RED LODGE QUADRANGLE.

Red Lodge southwest up Rocky Fork 10.8 miles.

	Feet.
Red Lodge, in stone sill of brick store of Carbon Mercantile Co.; bronze tablet stamped "5548"	5,554.222
Red Lodge, 2.6 miles south of, on southwest corner of bridge over West Branch; large nut marked "4795"	5,791.60
Red Lodge, 4 miles south of, 50 feet north of Rocky Fork, 100 feet west of ranch gate; paint mark on granite bowlder marked "5910"	5,907.25
Red Lodge, 4.6 miles south of, 15 feet east of road, opposite high limestone outcrop, in low 3 by 7 by 9 foot bowlder; aluminum tablet stamped "5977"	5,974.136
Red Lodge, 5.7 miles south of, 0.2 mile north of forest reserve line, at west margin of road (creek at east margin); paint mark on granite bowlder marked "6118"	6,114.73
Red Lodge, 6.6 miles southwest of, 300 feet southwest of ranch house, 0.8 mile south of forest reserve line, 10 feet east of road, in 5 by 10 foot granite bowlder; aluminum tablet stamped "6328"	6,324.706
Red Lodge, 7.8 miles southwest of, 1.9 miles south of forest reserve line, at east margin of road, 250 feet southwest of gate across road; paint mark on tip of pyramidal granite bowlder marked "6353"	6,349.932
Red Lodge, 8.8 miles southwest of, 1.4 miles south of pond to west of roads, 200 feet south of meadow, at east margin of road, 40 feet west of creek bank; paint mark on granite bowlder marked "6419"	6,415.94
Red Lodge, 10.2 miles southwest of, 1 mile northwest of creek forks, 700 feet northeast of fence, 15 feet north of road; paint mark on granite bowlder marked "6578"	6,575.44
Red Lodge, 10.8 miles southwest of, 0.4 mile east of forks of Rocky Fork, near west margin of small meadow, 40 feet south of road, in granite bowlder; aluminum tablet stamped "6670"	6,666.75

Point 3.6 miles southwest of Chance northwest along highways to point 3.2 miles northwest of Linley.

Chance, 3.6 miles southwest of, 500 feet northeast of road, 0.2 mile north of conical butte standing by river, 75 feet south of sandstone outcrop, 25 feet north of gulley, in sandstone bowlder; aluminum tablet stamped "4103"	4,100.05
Chance, 2 miles west of, 150 feet southwest of fence corner, 0.5 mile northwest of river, 15 feet southeast of road; iron staple driven into knot on fence post marked "4062"	4,058.67
Bell's ranch, 1 mile west of Clark Fork of Yellowstone River, on small knoll, at entrance to gap, 100 feet south of county road; iron post stamped "4085"	4,091.57
Red Lodge, 1 mile west of, 0.5 mile east of cemetery, at turn in road to west at center of roadway; highest point on bowlder marked "5671"	5,668.40

	Feet.
Red Lodge, 3.3 miles northwest of, 40 feet southwest of Willow Creek, at bridge, 30 feet northwest of road, in granite bowlder; aluminum tablet stamped "5511"	5,507.782
Red Lodge, 5.4 miles northwest of, 250 feet north of summit, south of vacant house, east of road, 10 feet west of fence; top of limestone bowlder marked "5513"	5,510.127
Red Lodge, 6.4 miles northwest of, 1,100 feet north of hilltop, 80 feet east of road, at fence; aluminum tablet stamped "5433"	5,429.621
Red Lodge, 7.8 miles northwest of, 0.3 mile south of Mr. Henry's house, 200 feet south of turn to west, in road at east margin of road; paint mark on top of bowlder marked "5143"	5,139.58
Red Lodge, 8.9 miles northwest of, 0.2 mile east of schoolhouse, 40 feet west of road to south, at south margin of roadway; painted square on granite bowlder marked "5141"	5,137.79
Red Lodge, 10 miles northwest of, 0.5 mile northwest of C. Schroeder's house, 150 feet east of corner, north side of road, in top of sandstone bowlder; aluminum tablet stamped "5216"	5,212.561
Red Lodge, 11.2 miles northwest of, 30 feet west of Teet Creek crossing, below ranch houses, at north margin of roadway; paint mark on granite bowlder marked "5194"	5,191.37
Red Lodge, 12.2 miles northwest of, 200 feet north of turn to north in road, 0.2 mile northwest of creek, at east margin of road; paint mark on highest point of granite bowlder, marked "5205"	5,201.52
Red Lodge, 12.8 miles northwest of, 3 miles east of Red Lodge Creek, 100 feet northwest of road summit, 30 feet north of road, in sandstone outcrop; aluminum tablet stamped "5187"	5,184.177
Linley, 1.7 miles northeast of, at brink of hill, 5 feet north of road; paint mark on granite bowlder marked "5258"	5,255.06
Linley, 0.5 mile east of, 25 feet east of culvert, at north side of road; paint mark on granite bowlder marked "5130"	5,127.31
Linley, 35 feet southeast of Linley store building, highest point on 3-foot granite bowlder; chiseled square marked "5184"	5,181.47
Linley, 1.1 miles west of, 250 feet west of corner and road to north, at north margin of road; paint mark on granite bowlder marked "5265"	5,261.55
Linley, 2.2 miles west of, 2.2 miles west of Red Lodge Creek, 400 feet east of house to north of road, at south side of road; paint mark on granite bowlder marked "5374"	5,371.08
Linley, 3.2 miles northwest of, 400 feet west of Butcher Creek bridge, in granite bowlder; aluminum tablet stamped "5249"	5,245.647
Red Lodge via stage road to Clark Fork bridge, at Bell's ranch.	
Red Lodge, 2 miles south of, east edge of mesa, 100 feet west of county road; iron post stamped "5985"	5,991.708
Foster's ranch, 0.2 mile southeast of, near southeast corner of sec. 10, T. 8 N., R. 20 W.; iron post stamped "5665"	5,671.192
Cummings Creek, 150 feet due south of large cottonwood tree, in northeast side of large granite bowlder which has large mound of rock piled on top, can be seen for miles; bronze tablet marked "5024;" datum point upper edge of tablet	5,030.751
Bell's ranch, Clark Fork, 1 mile west of, on small knoll, at entrance to gap, 100 feet south of county road; iron post stamped "4085"	4,091.579
Bell's ranch, 0.2 mile east of, east bank of Clark Fork of Yellowstone River near bridge in fence corner; iron post stamped "3999"	4,005.666

GRANITE PEAK QUADRANGLE.

Point 3.5 miles south of Yonce schoolhouse southwest up West Rosebud Creek 7.6 miles (single unchecked spur line).

	Feet.
Yonce schoolhouse, 3.5 miles south of, 0.5 mile north of deserted ranch house on west bank, in center of old road; paint mark on granite bowlder marked "5531"	5,528.000
Reeve's ranch, 2.4 miles north of, 0.3 mile south of gate across road, on slope, at east side of road; paint mark on granite bowlder marked "5600"	5,597.44
Reeve's ranch, west side of road, 0.5 mile west of Rosebud Creek; paint mark on granite bowlder marked "5974"	5,970.75
Reeve's house, opposite, 50 feet west of creek, near mouth of West Rosebud Canyon, in granite bowlder; aluminum tablet stamped "5834"	5,831.093
Reeve's ranch, 0.8 mile south of, 400 feet south of small creek, at east margin of road; point on granite bowlder marked "5862"	5,859.22
Reeve's ranch, 1.8 miles south of, on West Rosebud Creek, 60 feet north of small stream, 20 feet east of road; paint mark on granite bowlder	5,947.69
Reeve's ranch, 3.2 miles southwest of, 60 feet southwest of dry creek; point on granite bowlder marked "6216"	6,213.24
Reeve's ranch, 4.3 miles southwest of, 30 feet north of road, 600 feet north of outlet to lower lake on West Rosebud Creek, in 20-foot granite bowlder; aluminum tablet stamped "6353"	6,350.122

Point 3.2 miles northwest of Linley northwest along highways to Nye, thence south along trail to point 3.8 miles west of Cooke.

Linley, 4.1 miles northwest of, 800 feet east of Dry Butcher Branch, at south side of road; paint mark on granite bowlder marked "5361"	5,357.60
Linley, 5.4 miles northwest of, 400 feet southwest of three forks in road, 1.1 miles east of Sand Ford, 30 feet southwest of trail; paint mark on granite bowlder marked "5537"	5,533.740
Linley, 6 miles northwest of, 0.5 mile east of Sand Ford of East Rosebud Creek, 400 feet west of Spring Creek, 50 feet north of horseshoe bend in road, in granite bowlder; aluminum tablet stamped "5484"	5,480.895
Linley, 7.4 miles northwest of, 0.5 mile north of Sand Ford, 0.2 mile north of section corner, 175 feet west of road, on spur; paint mark on red bowlder marked "5442"	5,439.20
Linley, 8.1 miles northwest of, 1.3 miles west of Sand Ford, 1,100 feet west of divide east of Willow Creek, 20 feet north of road, in granite bowlder; aluminum tablet stamped "5523"	5,520.486
Linley, 9.5 miles northwest of, 300 feet east of Willow Creek, in center of road; paint mark on granite bowlder marked "5461"	5,458.45
Linley, 10.5 miles northwest of, 0.2 mile west of divide between Willow and Ingersoll creeks, 300 feet above knoll with clump of pines; highest point on granite bowlder marked "5498"	5,494.813
Linley, 11.4 miles northwest of, 1.1 miles northwest of divide between Willow and Ingersoll creeks, 600 feet southeast of lake, in 10-foot bowlder; aluminum tablet stamped "5715"	5,711.927
Yonce schoolhouse, 3.5 miles south of, 30 feet east of road west of Rosebud, 0.5 mile north of deserted ranch house on west bank, in center of old road; paint mark on granite bowlder marked "5531"	5,528.00
Red Lodge, 29.3 miles northwest of, 0.5 mile north of cabin on east bank of West Rosebud Creek, 20 feet east of road; chiseled square on large granite bowlder marked "5531"	5,528.11

	Feet.
Yonce schoolhouse, 1.2 miles south of, 0.5 mile west of Rosebud Creek, 450 feet north of section corner, 50 feet west of road, in 15-foot granite bowlder; aluminum tablet stamped "5312"	5,309.361
Yonce schoolhouse, 0.2 mile south of, 20 feet south of private road, 200 feet east of creek crossing; highest point on granite bowlder marked "5160"	5,157.12
Yonce schoolhouse, 1.5 miles southwest of, on sandstone at south margin of road; chiseled square marked "5257"	5,253.78
Yonce schoolhouse, 2.2 miles southwest of, 0.3 mile east of D. C. Bedford's ranch house, 10 feet south of road, in sandstone bowlder; aluminum tablet stamped "5275"	5,271.604
Dean, 2.7 miles east of, 0.4 mile east of divide on west margin of road; chiseled point on capstone of culvert marked "5375"	5,372.41
Dean, 1.2 miles southeast of, 400 feet northwest of Fishtail Creek crossing, 50 feet west of road, in standsone bowlder below sandstone outcrop; aluminum tablet stamped "5314"	5,311.236
Dean, 500 feet west of, 200 feet east of double culverts, at south margin of road; highest point of small granite bowlder marked "5223"	5,219.717
Dean, 2.7 miles west of, 0.4 mile east of Rock Creek crossing, 50 feet north of road, in sandstone bowlder; aluminum tablet stamped "5264"	5,261.070
Dean, 3.7 miles west of, 0.7 mile west of Rock Creek crossing, at summit, 30 feet south of road; highest point on small granite bowlder marked "5136"	5,132.57
Dean, 5 miles west of, 0.4 mile west of road to north, 40 feet south of road, 1.7 miles east of bridge over Stillwater River; chiseled square on granite bowlder marked "4982"	4,979.43
Nye, 0.5 mile south of, 750 feet west of Stillwater River bridge, 15 feet north of road, in granite bowlder; aluminum tablet stamped "4812"	4,808.732
Nye, 1 mile south of, 300 feet north of river, 40 feet north of road, on granite bowlder; chiseled square marked "4844"	4,840.54
Nye, 2 miles south of, 50 feet southwest of fence, 10 feet south of road; highest point on dark granite bowlder marked "4887"	4,883.723
Nye, 3.3 miles south of, 0.3 mile west of river and cabin, 25 feet west of road, 150 feet east of bank; highest point on granite bowlder marked "4859"	4,856.34
Nye, 4.1 miles south of, 1.5 miles north of Wood's meadow, at south margin of limestone outcrop, 40 feet west of road, in bowlder; aluminum tablet stamped "4873"	4,870.119
Nye, 5.4 miles south of, 85 feet northeast of shop at Dunbar's ranch; paint mark on granite bowlder marked "4950"	4,946.763
Nye, 6.7 miles south of, 1 mile north of Wood's ranch, 40 feet south of small creek, 5 feet east of road; paint mark on small granite bowlder marked "5011"	5,007.567
Nye, 7.7 miles south of, 200 feet north of B. F. Wood's house, in granite bowlder; aluminum tablet stamped "5058"	5,054.531
Nye, 8.7 miles south of, 1 mile south of Wood's ranch, 300 feet south of large bowlder below road, 50 feet east of large bowlder above road, at east margin of road; paint mark on granite bowlder marked "5189"	5,186.04
Nye, 9.6 miles south of, 2 miles south of Wood's ranch, at east margin of road, on creek bank; paint mark on granite bowlder marked "5416"	5,413.39
Nye, 10.9 miles south of, 3.3 miles south of Wood's ranch, 0.1 mile north of lake, 10 feet north of trail, at margin of woods, in 8-foot granite bowlder; aluminum tablet stamped "5704"	5,700.816
Nye, 11.8 miles south of, 750 feet north of upper end of lake, on shore; chisel mark on granite bowlder marked "5650"	5,647.02

	Feet.
Nye, 12.9 miles south of, 0.9 mile south of lower lake, 200 feet east of summit, at edge of track; paint mark on granite bowlder marked "5707"	5,704.18
Nye, 13.8 miles south of, 60 feet south of Roaring Creek, 10 feet west of trail, in granite bowlder; aluminum tablet stamped "5868"	5,864.751
Nye, 14.9 miles south of, 1 mile south of Roaring Creek, 700 feet south of small bridge, at east side of trail; paint mark on granite bowlder marked "5921"	5,917.80
Nye, 18.3 miles south of, 0.2 mile east of Stillwater River, opposite 300-foot butte, 0.5 mile north of Horseshoe Creek (to west), 600 feet north of small bridge, 5 feet east of trail, in granite bowlder; aluminum tablet stamped "6423"	6,420.378
Nye, 19.6 miles south of, opposite Horseshoe Creek, in small park, 5 feet west of trail; highest point of granite bowlder marked "6407"	6,404.14
Nye, 20.8 miles south of, 1.8 miles south of Horseshoe Creek, 200 feet south of north end of park, 15 feet east of trail, in granite bowlder; aluminum tablet stamped "6549"	6,546.161
Nye, 21.8 miles south of, 0.4 mile south of park, on east side of trail; paint mark on granite bowlder marked "6626"	6,623.222
Nye, 22.9 miles south of, 4 miles south of Horseshoe Creek, 300 feet south of river crossing, center of trail; paint mark on granite bowlder marked "6770"	6,767.07
Nye, 24 miles south of, 5 miles south of Horseshoe Creek, 0.4 mile north of Stillwater Ford, at north end of small park, 15 feet east of trail, in granite bowlder; aluminum tablet stamped "6945"	6,941.669
Nye, 25.3 miles south of, 650 feet south of ford below East Branch, at east margin of trail; paint mark on bowlder marked "7009"	7,006.123
Nye, 26.3 miles south of, 1.3 miles south of East Branch Ford, at east margin of trail; highest point on granite bowlder marked "7275"	7,271.55
Cooke, 12 miles north of, 450 feet north of ranger station 2, district 3, 20 feet west of trail, in granite bowlder; aluminum tablet stamped "7306"	7,303.415
Cooke, 10.7 miles north of, 350 feet south of small park, at west side of trail; highest point on granite bowlder marked "7421"	7,418.27
Cooke, 8.5 miles north of, 150 feet north of Stillwater Forks, 10 feet west of trail, in granite bowlder; aluminum tablet stamped "7882"	7,878.769
Cooke, 7.7 miles north of, 50 feet west of 8-mile cabin; highest point on granite bowlder marked "8340"	8,337.43
Cooke, 6.5 miles north of, 1 mile south of 8-mile cabin, 100 feet south of timber line, 5 feet north of trail; highest point on granite bowlder marked "8598"	8,595.114
Cooke, 5.5 miles north of, 1.5 miles north of pass, 425 feet west of run crossing, 5 feet south of trail; highest point on bowlder marked "U. S. B. M. 8894"	8,891.25
Cooke, 4.5 miles north of, 0.3 mile north of pass, in forks of trail, 100 feet south of creek; highest point on small bowlder marked "9379"	9,375.506
Cooke, 4 miles north of, south of pass, 170 feet west of stamp mill, 10 feet south of road, in copper-bearing rock; aluminum tablet stamped "9605"	9,602.396
Cooke, 2.7 miles north of, 175 feet northwest of road forks, 10 feet west of road; top of bowlder marked "8898"	8,894.836
Cooke, 1.5 miles northeast of, at road shunt; highest point on red granite bowlder marked "8396"	8,393.481
Cooke, 0.3 mile north of post office, 75 feet west of old Miller Creek road, in granite bowlder; aluminum tablet stamped "7651"	7,648.374
Cooke, 1.1 miles west of, 120 feet west of powder house, 10 feet south of road; highest point on small bowlder marked "7483"	7,479.97

Cooke, 2.2 miles west of, 160 feet west of bridge over creek to south, 15 feet north of road; highest point on small bowlder marked "7434"..... Feet. 7,430.534

Cooke, 3.8 miles west of, 40 feet east of National Park line, 20 feet north of road, in volcanic bowlder; aluminum tablet stamped "7378"..... 7,374.959

Granite Mountain, 12 miles northeast of Cooke, between the headwaters of West Rosebud and East Rosebud creeks and Clark Fork of Yellowstone River; highest point in Montana, elevation by vertical angles from primary levels in mountain pass north of Cooke..... 12,847

Fort Custer, Huntley, and St. Xavier Quadrangles.

ROSEBUD AND YELLOWSTONE COUNTIES.

The bench marks in the following list, except the one in the St. Xavier quadrangle, were originally established by the Reclamation Service in 1904 and redetermined by the Coast and Geodetic Survey in 1909. The elevations given are those furnished by the Coast and Geodetic Survey, based on the preliminary adjustment of 1911.

HUNTLEY QUADRANGLE.

Huntley along Chicago, Burlington & Quincy R. R. to Anita.

Huntley, 0.7 miles east of, at first crossing of Huntley main line canal under the Chicago, Burlington & Quincy R. R. track, in center of south coping, 11.5 feet south of the center of the Chicago, Burlington & Quincy R. R. track, 8 inches from the face of head wall; aluminum tablet..... Feet. 3,016.896

Huntley, 1.6 miles east of, 250 feet west of highway bridge over Huntley main line canal, 279.3 feet north of center of the Chicago, Burlington & Quincy R. R. track, 135.5 feet north of north water line of the canal; aluminum tablet..... 3,012.772

Huntley, 2.2 miles east of, opposite Chicago, Burlington & Quincy R. R. bridge 483, in a culvert crossing a small stream under the Huntley main line canal, in center of south coping of culvert, 94.5 feet north of the center of Chicago, Burlington & Quincy R. R. track, 0.55 foot from face of head wall; aluminum tablet..... 3,009.803

Huntley, 3.5 miles east of, opposite Chicago, Burlington & Quincy R. R. bridge 482, in concrete spillway for a small stream over the Huntley main line canal, at the south end of west parapet wall, 148 feet north of center of the Chicago, Burlington & Quincy R. R. track, 28 feet south of center of canal; bronze tablet..... 3,016.429

Ballantine, 3.9 miles west of, in second crossing of Huntley main line canal under the Chicago, Burlington & Quincy R. R., in center of south coping, 11 feet south of center of Chicago, Burlington & Quincy R. R. track, 0.75 foot from face of coping; aluminum tablet..... 3,010.150

Ballantine, 2.9 miles west of, opposite Chicago, Burlington & Quincy R. R. bridge 480, in a stream crossing over the Huntley main line canal, in east end of southwest coping, 172 feet south of center of Chicago, Burlington & Quincy R. R. track, 48 feet south of center of canal; aluminum tablet... 3,011.778

Ballantine, 2.2 miles west of, in turnout of lateral E from the Huntley main line canal, in center of top of concrete head gate, on north side of canal, 90 feet south of center of Chicago, Burlington & Quincy R. R. track; aluminum tablet..... 3,001.851

Ballantine, 183 feet northwest of northwest corner of the platform of the railway station, 146 feet north of center of Chicago, Burlington & Quincy R. R. track; aluminum tablet..... 2,999.085

	Feet.
Ballantine, 0.3 miles east of, at third crossing of the Huntley main line canal under the Chicago, Burlington & Quincy R. R., in center of north coping, 11.6 feet north of center of Chicago, Burlington & Quincy R. R. track, 0.65 foot from face of head wall; aluminum tablet	3,004.480
Ballantine, 1.6 miles east of, at crossing of lateral H. A. and the Chicago, Burlington & Quincy R. R., in center of concrete coping, 11 feet north of center of Chicago, Burlington & Quincy R. R. track, 0.5 inch from face of head wall; aluminum tablet	3,036.913
Ballantine, 2.4 miles east of, in crossing of lateral H. B., under the Chicago, Burlington & Quincy R. R., center of coping, 10.5 feet north of center of Chicago, Burlington & Quincy R. R. track, 3 feet above grade; aluminum tablet	3,032.501
Ballantine, 3.4 miles east of, at crossing of lateral H. C. and Chicago, Burlington & Quincy R. R., in center of coping, 10.5 feet north of center of the Chicago, Burlington & Quincy R. R. track, 1.6 feet above grade; aluminum tablet	3,029.040
Anita, 2 miles west of, in crossing of high line canal, Huntley project, and the Chicago, Burlington & Quincy R. R., in center of coping, 44 feet south of center of Chicago, Burlington & Quincy R. R. track; aluminum tablet	3,032.372
Anita, opposite station sign, 79 feet northeast of center of Chicago, Burlington & Quincy R. R. track, 3 feet outside of right of way fence, 3 feet below grade; aluminum tablet	3,052.007

FORT CUSTER QUADRANGLE.

Anita along Chicago, Burlington & Quincy R. R. to Toluca.

Corinth, nearly opposite water tank, 125 feet west of center of Chicago, Burlington & Quincy R. R. track, 40 feet west of right of way fence, 200 feet southwest of southwest abutment of water tank; aluminum tablet	3,084.186
Toluca, 133 feet south of southeast corner of railroad station, 132 feet southwest of center of Chicago, Burlington & Quincy R. R. main track, 2 feet northeast of right of way fence; aluminum tablet	3,243.986

ST. XAVIER QUADRANGLE.

Bench mark in Rosebud County.[1]

T. 9 S., R. 33 E., 2 miles northwest of Little Bighorn River, at fork of Bald Mountain and Lodgegrass road; iron post stamped "SIIER 4553"	4,562.231

[1] This bench mark was established in 1899 by the United States Geological Survey and is based on primary leveling from Sheridan, Wyo.

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DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

BULLETIN 483

ECONOMIC GEOLOGY

OF

RICHMOND, VIRGINIA, AND VICINITY

BY

N. H. DARTON

WASHINGTON
GOVERNMENT PRINTING OFFICE
1911

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ECONOMIC GEOLOGY OF RICHMOND, VIRGINIA, AND VICINITY.

By N. H. DARTON.

INTRODUCTION.

The geologic formations in the vicinity of Richmond contain materials of considerable economic importance, notably a very large amount of high-grade granite and wide areas of valuable brick clays. Both of these are extensively utilized, not only for local consumption but for shipment to other places. The granite industry is in a moderately prosperous condition, but the production was formerly much greater than it is at present. Richmond is most favorably situated for the distribution of its economic products, for it has several railroads and is on tidewater.

There is not much literature on the geology of the Richmond region. In the report of the Geological Survey of Virginia, by Prof. W. B. Rogers, issued in 1836–1840, the general relations of the rocks were described and some additional facts have been published by subsequent observers.[1]

Some features of the economic geology were described by T. L. Watson in 1906 [2] and in a later report on the granites of the southeastern Atlantic States.[3]

GEOGRAPHIC FEATURES.

Eastern Virginia consists of two provinces—the Coastal Plain to the east and the Piedmont province to the west—but the two merge insensibly along a zone which lies near Richmond, Fredericksburg, and Washington. The Piedmont province is a region of hard rocks and rolling topography. It was formerly a plateau, but now is so deeply eroded by drainageways that but little of the plateau surface remains.

[1] Coryell, Martin, Diatomaceous sands of Richmond, Va.: Proc. Am. Inst. Min. Eng., vol. 4, p. 230; The Virginias, vol. 2, 1881, pp. 6–7. Darton, N. H., Mesozoic and Cenozoic of eastern Virginia and Maryland: Bull. Geol. Soc. America, vol. 2, 1891, pp. 431–450. Fontaine, W. M., The Potomac formation in Virginia: Bull. U. S. Geol. Survey, No. 145, 1896. Darton, N. H., Artesian well prospects in the Atlantic Coastal Plain region: Bull. U. S. Geol. Survey, No. 138, 1896.

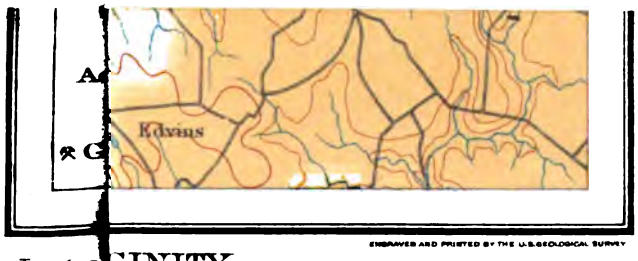
[2] Watson, T. L., Mineral resources of Virginia: The Virginia Jamestown Exposition Commission, Lynchburg, 1907.

[3] Watson, T. L., Granites of the southeastern Atlantic States: Bull. U. S. Geol. Survey No. 426, 1910.

In its eastern part it has an average altitude of about 200 feet above sea level, but it rises gradually toward the west. The streams that cross it flow through narrow valleys in rocky channels. The Coastal Plain is a region of clay, sand, and other soft materials, laid down in a succession of relatively thin sheets on an eastward-sloping floor of granite and other crystalline rocks and dipping gently to the east. It consists mainly of a wide plateau of moderate height trenched by broad, terraced valleys of numerous streams. The larger streams that flow from the Piedmont province are tidal estuaries as far inland as the zone in which the hard rocks rise from under the deposits of the Coastal Plain and become sufficiently high to cause rapids. As the rise of these rocks is in general moderately steep the river valleys narrow in a short distance into rocky gorges which mark the change from the Coastal Plain to the Piedmont province. Richmond is situated at the head of the estuarine portion of James River, and is built partly on the Coastal Plain plateau and partly on the slopes that descend to the river. Manchester is built on a river terrace. The plateau in the Richmond region stands at an average altitude of 200 feet above sea level and has a notably smooth surface. (See Pl. II, *A*.) It stretches far to the west, northeast, and southeast, but is deeply trenched by numerous minor streams, notably Shockoe and Gillis creeks and their branches, and has been widely removed by James and Chickahominy rivers. It reappears south of James River, in the region west of Manchester, where its altitude for some distance is about 200 feet above sea level. The smoothness and the gentle eastward slope of the plateau are notable. West of longitude 77° 30′ it rises at a slightly more rapid rate. The valley of James River is bordered at several heights by terraces, the most extensive of which is the broad one extending southward from Manchester. This terrace rises from the freshet plain of the river and by successive steps attains an altitude of about 100 feet and a width of nearly 2 miles. Apparently it is developed on granite thinly covered with clay, sand, and gravel. A portion of this terrace lies on the north side of the river in Richmond, where it constitutes a well-defined shelf having an altitude of 70 to 90 feet along Carey Street and Canal Street, from Sixth to Eleventh Street. It also borders the valleys of Shockoe and Gillis creeks, where it has an altitude of 30 to 80 feet. Rocketts is built on part of this terrace and there are other parts of it on the east side of the river below the mouth of Almond Creek.

GENERAL STRUCTURAL RELATIONS.

The cross section in Plate I shows the principal structural features of the Richmond region. It passes through the center of Richmond from northwest to southeast. The granite of the Piedmont region descends abruptly under sedimentary strata of the Coastal Plain in



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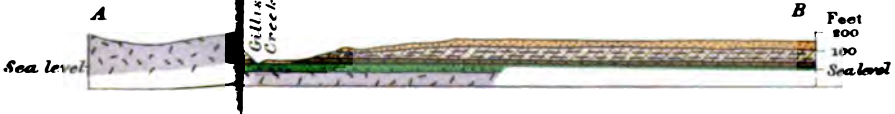


the central part of the city and farther southeast it lies several hundred feet below the surface.

The succession of overlying strata is as follows:

Sedimentary rocks in the Richmond region.

System.	Series.	Group.	Formation.	Character.	Thickness.
Quaternary.	Pleistocene.	Columbia.	Undifferentiated.	Loam, sand, and gravel on terraces.	*Feet.* 5–35
Tertiary.	Pliocene (?).	.....	Lafayette.	Loam, sand, and gravel of orange tint.	30
	Miocene.	Chesapeake.	Calvert.	Clay with sand and diatom admixture.	0–80
	Eocene.	Pamunkey.	Aquia.	Dark sand; gravel at base.	0–25
Cretaceous.	Lower Cretaceous.	Potomac.	Patuxent (may possibly include some Patapsco at top).	Arkosic sand with gravel, cross-bedded.	0–50

Except the deposits of the Columbia group, which lie in terraces in the valleys, these strata form a succession of widely extended sheets that dip gently to the east. The Lafayette formation constitutes the mantle of the general plateau of the region and extends far to the west, overlapping the edges of the older formations. Its inclination to the east is slight and irregular and it also slopes to some extent into the valleys.

To the east it lies unconformably on the Calvert formation, but without notable discordance of dip or deep channeling.

The Calvert is the lowest formation of the Chesapeake group and, as the other formations of the group are absent, a long interval of time between the Calvert and Lafayette formations is not represented by deposits at Richmond. The Calvert formation overlaps on to the granite in the western part of the city and has a general dip to the east at a very low rate. It lies unconformably on the Aquia formation and thickens slightly to the east and southeast. The Aquia formation is the lower formation of the Pamunkey group, the upper formation of that group, the Nanjemoy, being absent. Therefore there is a considerable hiatus between the Aquia and Calvert formations. The Aquia formation is a thin sheet of dark sand developing into a marl toward the east. It dips gently eastward and also gradually thickens in that direction. It lies unconformably on the Potomac group, there being a hiatus between the two, represented in the other regions by earlier Tertiary and a great thickness of Cretaceous sediments. The Potomac group present in this area probably comprises only the Patuxent formation of the region farther north. The beds lie unconformably on a somewhat irregular surface of the old granite. This surface rises to the west as a shore line

against which the edges of the Patuxent and Aquia formations abut a short distance west of Shockoe Creek valley, as shown in the cross section on Plate I. Both of these formations and most of the Calvert deposits have been removed in the area west of the river, through Manchester, and for some distance south.

DESCRIPTION OF THE ROCKS.

GRANITE.

General features.—The granite which underlies the Richmond region is mostly massive and is of light-gray color. It consists mainly of the three crystalline minerals, quartz, feldspar, and mica, uniformly intermixed but varying somewhat in proportions and texture. In the western part of Richmond and to the west, and in Chesterfield County, the rock is at or near the surface, although it is extensively mantled by the Lafayette formation on the higher land. In the central part of Richmond and farther east the granite sinks at a steep grade and passes beneath the Patuxent formation. In its area of outcrop much of it is decomposed, so much so in some places that the resulting material is scarcely more than a compact sand, mostly of reddish and yellow tints. The granite outcrops extensively in the cliffs along both sides of James River above Richmond and causes the falls which begin at the old Manchester bridge. The granite is revealed by Brook Run and on Goode Creek and Broad Rock Branch east and south of Clopton. It appears in a small outcrop in the west bank of James River just below the mouth of Goode Creek and is exposed at intervals in the terrace slopes southeast of Manchester. (See Pl. II, *B*.)

In dredging and deepening the channel it has been found that the rock extends all along the river bottom for several miles below Richmond. Granite has been reported at the following depths in borings in the Richmond region:

Borings reaching granite in the Richmond region.

	Feet.
Hotel Jefferson, Franklin and Jefferson streets	118
Murphy's Hotel, Broad and Eighth streets	140
Richmond Apartments, Ninth and Grace streets	140
Chesterfield Apartments, Franklin and Shafter streets	95
Kingan Slaughterhouse	90
Kingan & Co., Fifteenth and Carey streets	12
Home Brewery, Harrison and Clay streets	98
Merchants Cold Storage, Sixth and Byrd streets	69½
Ginter Park	165
Bellevue Park	85
Paul Ice Factory, Manchester	12½
Westhampton Park	120

A. THE LAFAYETTE PLAIN NEAR RICHMOND, VA.

B. JAMES RIVER FALLING OVER GRANITE LEDGES ABOVE RICHMOND, VA.

In some of these records, notably the last, the figures given denote depth to "hard rock," the overlying decomposed granite being disregarded by the driller. Some years ago a small outcrop of granite with quartz veins was visible in the west bank of Shockoe Creek just south of Marshall Street. Rogers also referred to one of hornblende granite to the left (north) of the crossing of Main Street. Both were overlain by the Patuxent formation and are now covered.

Structural relations.—The granite of the Richmond area appears to be a huge batholith extending far to the north and south. It passes beneath the Triassic overlap to the west and underlies the Coastal Plain to an undetermined distance east. Its contacts with adjoining old rocks have not been studied, and therefore its age is not known. Some portions of this great granite mass show gneissic structure, but this is only noticeable at a few places and is a very subordinate feature about Richmond. Watson [1] has described an occurrence of inclosed blocks of banded granite gneiss in the McCloy quarry, 2 miles south of Manchester. The blocks are several feet wide, and the massive granite cuts across the schistosity and a thin interlaminated mass of pegmatite. Still later dikes of pegmatite cut both rocks. These relations show that the gneiss was developed before the intrusion, and doubtless it is the rock through which the granite was forced. Watson reports an outcrop of gneiss in the old State quarry north of Granite station, but the contact is not exposed. The coarser-grained lighter-colored granite is cut by dikelike masses of the finer-grained darker-colored granite, and both are cut by the narrow pegmatite dikes and a few other later intrusives. Some of the most instructive exposures of these features are in the Smith quarry, on the south bank of James River, 2 miles above Richmond. As described by Watson, there are here several intrusions of the dark finer-grained rock in the coarser granite, and at one point masses of the latter are included. Narrow pegmatite dikes cut across the contact at several places in this quarry.

Petrography.—In order to ascertain the mineral character of the granites in the Richmond region, a series of representative samples was collected, mostly from quarries in operation. These were examined under the microscope by E. S. Bastin. All of the granites were found to be closely similar in mineralogic composition, consisting of quartz, feldspars, and biotite in granular aggregation. Quartz and the feldspar known as microcline are the predominant constituents, and there are smaller varying amounts of the feldspars known as orthoclase and oligoclase. The greenish brown mica of the variety known as biotite is present in moderate amount. Various other minerals

[1] Watson, T. L., Granites of the southeastern United States: Bull. U. S. Geol. Survey No. 426, 1910, p. 80.

occur in small proportions. The rocks differ mainly in coarseness, in regularity of grain, and in percentage of the subordinate feldspars. Rock from the McCloy quarry is almost identical with samples from the James River Granite Corporation quarries. Closely similar but somewhat coarser rocks were collected at the McGowan quarry and on the river bank south of Belle Island. Granites from the Wade and the Green quarries are also closely similar. Granites from the McGowan quarry and the quarry near the mouth of Goode Creek are more irregular in texture than the others and characterized by greater abundance of micrographic intergrowths of feldspar and quartz. They therefore show pegmatitic tendencies, though this is hardly apparent in the hand specimens. Incipient gneissic structure appears in some of the specimens.

The rocks collected were very fresh and constituents injurious from the commercial standpoint are practically absent from all.

McCloy quarry: The rock at the McCloy quarry is of granular texture with grains of nearly uniform size averaging about one-half millimeter in diameter. The dominant light-colored minerals are microcline and quartz, with orthoclase subordinate and an occasional grain of oligoclase. The principal dark-colored mineral is greenish-brown biotite. The minor constituents are muscovite, magnetite in small grains, and apatite. Occasional micrographic intergrowths occur at contact of quartz and microcline grains, and secondary muscovite has developed along cleavage cracks in some of the feldspars.

Richmond Granite Co.: This granite is a light-colored rock of somewhat irregular granular structure in which the feldspars are as much as 5 millimeters in length. The average size of grains, however, is about 1½ millimeters. The dominant light-colored minerals are microcline and quartz; and though oligoclase is abundant, it is less in amount than the microcline. The only dark-colored mineral is greenish-brown biotite, but some of the light-colored mica, muscovite, is present.

The rock exhibits signs of slight alteration, for the biotite shows some development of chlorite and the oligoclase is frequently clouded with secondary muscovite and some calcite. The microcline shows very little alteration, but secondary muscovite often forms strips along cleavage cracks in the feldspar. There are occasional grains of epidote which may be primary. The rock differs from most of the other granites in being somewhat coarser and showing a greater abundance of oligoclase.

Wade quarry: The granite at the Wade quarry is of nearly uniform granular texture, and the average size of grain is about 1 millimeter. The dominant light-colored minerals are microcline and quartz, the latter occurring in part as small globules inclosed by the feldspar. There is also some orthoclase and a very small amount of oligo-

clase. The dominant dark-colored mineral is olive-green biotite in flakes, some of which are 4 millimeters in length, though most are less than 2 millimeters. There is a smaller amount of muscovite and a few small crystals of zircon. The quartz and feldspar show some micrographic intergrowths.

The rock is very fresh, though some shreds of secondary muscovite are developed in a few of the feldspars.

Alvin Netherwood quarry, Granite station: The structure of this granite is granular, and the grains are of nearly uniform size, averaging 2 millimeters in diameter, although some of the feldspars are 3 millimeters long. The dominant light-colored minerals are microcline and quartz with orthoclase and oligoclase in subordinate amounts. Olive-green biotite is the only abundant dark-colored mineral. A small amount of muscovite is present, some of it intergrown with biotite, and there are scattered grains of magnetite and original epidote. There is some micrographic intergrowth of feldspar and quartz. Some of the biotite flakes show partial alteration to chlorite, and some secondary muscovite and a little calcite are developed in the feldspars.

Green quarry: The granite at the Green quarry is of granular structure, the grains, which are of nearly uniform size, being about 1 millimeter in diameter. The dominant light-colored minerals are microcline and quartz, and greenish-brown biotite is the only abundant dark-colored constituent. Magnetite, muscovite, apatite, and zircon occur in small amounts. Micrographic intergrowths of quartz and feldspar are occasionally present. Secondary muscovite is developed in many of the feldspars, and some epidote associated with biotite is probably secondary.

James River Granite Corporation: The ordinary granite from the quarry of this company is of uniform grain whose average size is about one-half millimeter. The dominant light-colored minerals are microcline and quartz with oligoclase also moderately abundant. Greenish-brown biotite is the principal dark-colored mineral. Muscovite, magnetite, apatite, and zircon occur in minor proportions. Micrographic intergrowths of quartz and feldspar are present but not abundant. Shreds of secondary muscovite are developed in some of the feldspars.

McGowan quarry: The granite from the McGowan quarry is a beautiful gray stone of uniform texture. Under the microscope it shows considerable variation in the size of the mineral grains, the average size being about 1 millimeter. The dominant light-colored minerals are microcline and quartz, and oligoclase is moderately abundant. Grayish-brown biotite is the only dark-colored mineral. Muscovite, epidote, and zircon also occur in small amount, and the epidote, though generally associated with biotite, has sharp borders

and appears to be an original constituent. Micrographic intergrowths of quartz and feldspar are abundant. Secondary muscovite is developed in some of the feldspars.

Smith quarry: The coarser variety of the granite in the Smith quarry shows much variation in size of the mineral grains, and though the average size of grain is about 1½ millimeters some feldspars are 4 millimeters long and some biotite flakes 3 millimeters. The dominant light-colored minerals are microcline and quartz and considerable oligoclase is also present. Greenish-brown biotite is the principal dark-colored mineral and it is notable that apatite is abundant. Muscovite, magnetite, and zircon occur in smaller amounts. Micrographic intergrowths are moderately abundant. Secondary muscovite and a little calcite develop in some of the feldspars.

The finer-grained rock in the Smith quarry has grains of nearly uniform size, the average diameter being about one-half millimeter. The dominant light-colored minerals are microcline, quartz, and orthoclase. Oligoclase and muscovite occur in smaller amounts. The principal dark-colored mineral is greenish-brown biotite. Apatite, magnetite, zircon, and original epidote occur in scattered grains. Some micrographic intergrowths of quartz and feldspar are present. Secondary muscovite is developed in some of the feldspars. Part of the rock in this quarry shows considerable schistosity.

South end of bridge to Belle Island: A sample of granite from an old small quarry on the south bank of James River, opposite Belle Island, has the common granular structure, with grains of nearly uniform size averaging about 1 millimeter in diameter. The dominant light-colored minerals are microcline and quartz, with orthoclase and oligoclase subordinate. The principal dark-colored mineral is greenish-brown biotite. Magnetite and apatite occur in scattered grains. Micrographic intergrowths of feldspar and quartz are present but not abundant. Secondary muscovite and some calcite are abundant in many of the feldspars.

Quarry on west bank of James River at mouth of Goode Creek: This granite has an irregular granular structure, the grains varying greatly in size; the average diameter is about one-half millimeter. The dominant light-colored minerals are microcline and quartz with muscovite and oligoclase subordinate. The principal dark-colored mineral is greenish-brown biotite. Apatite and epidote occur as scattered grains. Secondary muscovite develops in some of the feldspars.

Analyses.—Analyses of composite samples of various kinds of granite have been made by William M. Thornton, jr., in the laboratory of the Virginia Geological Survey.[1] They are as follows:

[1] Bull. Virginia Geol. Survey No. 1A, Ann. Rept. of mineral production of Virginia for 1908, p. 81.

Analyses of granites from Richmond area.

	1	2	3	4	5
Silica (SiO_2)	72.27	71.19	70.83	69.44	69.29
Alumina (Al_2O_3)	14.30	14.01	12.70	15.46	14.07
Ferric oxide (Fe_2O_3)	1.16	1.66	2.67	1.31	2.59
Ferrous oxide (FeO)	.97	1.29	1.36	1.43	2.03
Magnesia (MgO)	.70	.44	.53	1.01	1.32
Lime (CaO)	1.56	2.04	1.88	2.11	2.76
Soda (Na_2O)	3.46	3.56	3.49	3.97	2.89
Potash (K_2O)	5.00	4.45	4.83	4.25	2.87
Water to 110°C	.04	.04	.07	.07	.06
Water 110°C	.25	.33	.34	.29	.37
Titanic oxide (TiO_2)	.31	.35	.41	.48	.50
Manganese oxide (MnO)	Trace	.02	.03	.03	.08
Carbon dioxide (CO_2)	.21	Trace.	Trace.	Trace.	Trace.
Phosphoric acid (P_2O_5)	.02	.34	.33	.22	.26
	100.25	99.72	99.47	100.07	99.09

1. Westham quarries, Chesterfield County, Va., 4½ miles west of Richmond. Medium textured and medium gray biotite granites.
2. McGowan, Netherwood, and Donald quarries, Chesterfield County, and Mitchell and Copeland quarries. Fine-grained dark blue-gray biotite granites.
3. Netherwood, Old Dominion Granite Development Co., Kremm and Middendorf quarries, Chesterfield County. Medium coarse textured and medium gray biotite granites.
4. McIntosh quarry, Chesterfield County, 5 miles west of Richmond, Va. Medium textured and medium gray biotite.
5. Middendorf quarry near Manchester. Medium coarse textured gray biotite granite.

POTOMAC GROUP.

PATUXENT FORMATION.

General relations and character.—The Patuxent formation underlies the eastern part of Richmond and the region east and south. Its western margin probably is near the capitol building, where it abuts against an upslope of granite, as shown in the cross-section (Pl. I). Its outcrop extends along the east bank of James River to the south from the mouth of Shockoe Creek, and there are extensive exposures in the river bluffs and along Shockoe and Gillis creeks. In this area the formation is less than 50 feet thick, but doubtless the thickness increases somewhat in the underground extension of the formation to the eastward. It is possible that the Patuxent formation as here described and mapped may include a representative of the Patapsco formation at the top, but it is believed that all of the deposits belong to the Patuxent.

The materials of the Patuxent formation are mainly sand and gravel. The sand consists largely of angular grains of quartz, but it is generally mixed with feldspar in a more or less decomposed condition. This mixture is commonly known as arkose. Considerable mica is present in places. Clay occurs in streaks and admixture with the sand and also in the form of pebbles. The character of the deposit is so variable that no two exposures present the same succession, but the arkosic sand containing pebbles and bowlders predominates. Most portions of the exposures show strong cross-bedding and rapid changes in the character of the material. Some of it is consolidated into a soft sandstone which disintegrates rapidly on exposure. The

gravel and bowlders occur in irregular deposits through the sands and consist largely of quartz and quartzite with granites and other varieties of crystalline rocks.

Local features.—The Patuxent formation appears most extensively in the face of the low bluff just south of Carey Street from Twenty-fourth Street to Rochelle Street and thence in slopes east to Williamsburg Avenue and Thirty-second Street. East of Twenty-fourth Street it rises from 3 to 5 feet above the railroad to a contact with the Aquia formation at 20 feet above sea level. The material is a coarse light gray and buff cross-bedded arkosic sand containing some bowlders. One bowlder bed 3 feet below the base of the Aquia formation is 2 feet thick and 25 feet long. The formation rises higher east of Twenty-eighth Street, cutting off the Aquia beds, and is well exposed in deep cuts of the Chesapeake & Ohio Railway extending to Rocketts Avenue and beyond. The cut exposes 25 feet in its deepest part, as shown in Plate III, *B*. The arkosic sand contains pebbles of clay and quartzite. This exposure continues eastward to Thirty-second Street, where there is an excellent outcrop of the contact of the Patuxent and Aquia formations in and near a small creek which crosses the Williamsburg Road at Thirty-second Street. The formation appears again in a large gravel pit a few rods farther south on the south bank of Gillis Creek. This pit is a few yards above the crossing of the Chesapeake & Ohio Railway. The formation here consists of the common cross-bedded arkosic sand of gray color containing pebbles and bowlders. It is overlain by the Columbia group, consisting largely of bowlders and pebbles. The features at this place are shown in Plate V, *B*, in which the Columbia-Patuxent contact is nearly on a level with the heads of the men. Farther up Gillis Creek there are scattered outcrops of the formation, notably at the bridge of the National Cemetery Road, where the exposure is continuous for some distance. The materials are light-gray arkosic sand, with scattered deposits of pebbles. Its surface rises somewhat up stream from the bridge, but in about one-half mile it passes beneath the Aquia formation in the bottom of the creek. The contact is covered. There was formerly a 15-foot bluff of the formation between the creek and the road on the south side of Gillis Creek, just east of the crossing of the Williamsburg Road. It contained bowlders of green clay and was capped by the deposits of the Columbia group.

The Patuxent formation is extensively exposed along the river bank in Rocketts from the cedar works to the wharfs near the mouth of Almond Creek—a distance of about three-fourths of a mile. The best exposures are at Louisiana and Orleans streets, where the formation rises about 30 feet above the river to the base of the Columbia group, which caps the terrace at Rocketts. According to well-borings its base is 15 feet below sea level where the granite is found.

A. WEST SLOPE OF SHOCKOE CREEK VALLEY, NEAR INTERSECTION OF TWELFTH AND LEIGH STREETS, LOOKING SOUTHWEST. CALVERT FORMATION CAPPED BY LAFAYETTE.

B. PATUXENT FORMATION IN CUT OF CHESAPEAKE & OHIO RAILWAY AT BRIDGE OF MAIN STREET AT LESTER STREET, RICHMOND, VA.

The material is the typical arkosic sand, with pebbly anb powldery streaks. One thin layer of carbonaceous sandy shale occurs in the formation in this exposure.

Two small exposures appear on the east side of Almond Creek, one on the road and another at the pit for molding sand east of the brickyards. Here the Patuxent is capped by the Aquia formation 3 to 5 feet above the bottom of the valley. The principal exposure of the formation in the bank of Shockoe Creek extends from a point near the intersection of Eleventh and Balding streets nearly to the Turpin-Washington Street crossing. It exhibits from 5 to 16 feet of cross-bedded arkosic sand, with bowlder beds in part conglomeratic. It is overlain by deposits of the Columbia group. Many years ago, according to Prof. Rogers, 8 feet of the formation were exposed in a low knoll in the bottom of the valley just north of Main Street. There was a mill at this place and the beds were cut by the race, the underlying granite outcropping in the creek nearby. These features have long since been covered. A small exposure of Patuxent formation lying on granite was visible some years ago on the west bank of Shockoe Creek just below Marshall Street. The thickness exposed was 8 feet and the material a gray and buff arkosic sand, with pebbles scattered through it. At the base is a 6-foot layer of conglomerate. Another exposure appeared on the west bank of the creek at Clay Street, capped by weathered Aquia formation with a pebbly bed at the base such as commonly occurs. The contact is about 32 feet above sea level. A small exposure was noted in a sewer near the corner of Turpin and Thirteenth streets, capped by deposits of the Columbia group. This is a short distance south of the large exposure extending along the creek bank nearly to Balding Street. Just above the point at which the Seaboard Air Line Railway crosses Shockoe Creek at Fourteenth Street below Turpin Street, there is a ledge of brown conglomerate 30 feet long, 20 feet wide, and 2 feet thick. Though it is probably the base of the Columbia, it may be the Patuxent. The same doubt exists as to a gravel bed at the bridge. The Patuxent formation was reported in a well at the Exchange Hotel, on Broad and Thirteenth streets. This well penetrated a bowlder bed at a depth of 77 feet, probably at the base of the Aquia formation, lying on Patuxent beds extending to the bottom of the well at a depth of 84 feet.

PAMUNKEY GROUP.

AQUIA FORMATION.

General relations and character.—The only formation of the Pamunkey group which is present in the Richmond area is the Aquia. The western edge of the Aquia formation extends into the central part of Richmond, where it becomes thinner against the rising slope of

the granite. Probably it overlaps a short distance beyond the edge of the Patuxent formation not far west of the capitol building. The formation is cut through by the lower parts of valleys of Shockoe, Gillis, and Almond creeks, in which it is exposed at intervals lying on the Patuxent formation. It also appears in various gullies along the east bank of James River south of Almond Creek. The principal material is a soft sand, mostly of a mottled gray and black color, which weathers to a reddish buff tint on the oxidation of the contained iron. At the base is a bed of gravel about a foot thick. The greatest thickness of the formation, so far as could be ascertained, is 25 feet, but in places it is only 12 to 15 feet thick.

Shockoe Valley.—In ravines on the west side of Shockoe Creek valley, W. B. Rogers[1] reported the following beds in the Aquia formation:

> The lower portion, from 6 to 10 feet thick, consists of a sand mixed with a small proportion of clay of yellowish gray color mottled with brown. It contains greensand (glauconite) grains irregularly scattered through it. Abundant casts of *Cardita planicosta*, *Turritella mortoni*, and other forms, in part with the shells in very soft condition. Next above is a member consisting of a mixture of dark olive or greenish clay and sand containing grains and granules of greensand. This bed, which is about 12 feet thick at most, abounds in fish teeth, especially of genus *Otodus* and *Ondontapis*, and coprolites, mostly small. Next above is a second sandy bed of light-yellowish tint mottled with brown and barred by thin irony layers. It is also highly fossiliferous. Some distance up the ravine it is 8 feet thick, but it thins out to the east towards the mouth of the hollow, and its upper surface exhibits evidence of irregular denudation prior to the deposition of the deposits of Miocene age which lie on it.

The formation is well exposed at intervals along the west side of Shockoe Valley, notably in the three deep gullies between Leigh Street and the locomotive works at Seventh Street crossing, and also in the railroad cut near the line of Eleventh Street (extended). There is a member of dark sand at the top lying on a harder layer containing considerable iron. The latter weathers to a buff color and grades down into 15 to 20 feet of dark-gray sands containing considerable glauconite and many fossils, mostly in the form of casts. The total thickness is about 25 feet. The upper surface appears to rise somewhat in the vicinity of Eighth Street. In the deep gully on the line of Eighth Street the upper 12 feet of the formation is well exposed, consisting of dark sand overlain unconformably by clay of the Calvert formation. There are exposures of Aquia formation in the bank of Shockoe Creek, notably on the line of Eighth and Ninth streets and halfway between Tenth and Eleventh. The formation extends up the creek bed to a point a rod or two above the first main forks (Seventh Street), but the contact here is concealed by filling. A small outcrop of the Aquia formation is visible on Valley Street on the east side of Shockoe Valley near the line of Fourteenth Street extended northward.

[1] Proc. Boston Soc. Nat. Hist., vol. 7, pp. 61-62, 1861.

A small projection of the Aquia formation appears in the bluff south of Carey Street just east of Twenty-fourth Street and extends for 200 to 300 yards. About 10 feet of the formation are exposed, lying on the irregular surface of the Patuxent formation at an altitude of 20 feet, and capped by deposits of the Columbia group and street filling. The material is greenish-gray, mottled sand containing gravel and bowlders in the lower 2 or 3 feet, the coarsest part being at the bottom. A rise of the Patuxent surface to the east cuts off the formation near Twenty-sixth Street.

Twenty-eighth Street to Gillis Creek.—The Aquia formation is extensively exposed along the base of the hills on Main Street and Williamsburg Avenue from Twenty-eighth Street east to Gillis Creek. On the northwest corner of Williamsburg Avenue and Thirtieth Street, just above the street level, are 3 feet of coarse brown sand and 5 feet of coarser sand of green color variegated with buff blotchings, both typical of the formation in its weathered condition. On its surface lies the Calvert formation, of which the base consists of clay with sandy streaks, clay breccia and ironstone layers. Main Street rises to the top of the Aquia formation between Twenty-seventh and Twenty-eighth streets, where exposures cease. Williamsburg Avenue rises to the top, or very near to it, at Thirty-first Street, and as it descends to the southeast this avenue cuts into the formation until between Thirty-first and Thirty-second streets the full thickness of 25 feet is exposed. The material is sand of mottled brown and green color with a 10 to 20 inch deposit of bowlders and pebbles at the base. Next below is exposed 4 feet of arkose belonging to the Patuxent formation. The top of the Aquia formation extends north from this point up the depression followed by the old railroad line to a point within a few yards of the mouth of the tunnel, or approximately at the intersection of Thirtieth and Grace streets. The formation contains a zone of iron concretions about a foot below the Calvert contact. It is all somewhat glauconitic.

There are only a few exposures of Aquia formation in Gillis Creek valley. There was formerly a pit for sand in the flat west of the crossing of the National Cemetery Road by the railroad and west of a small gully. There are several pits for molding sand and overlying gravels south of the National Cemetery Road south of the creek. Its basal gravelly bed is in contact with Patuxent formation a half mile above that road. The formation is exposed in stream cuts at the dam, where it is capped by deposits of the Columbia group. It does not quite reach the mouth of Stony Run.

Almond Creek southward.—The Aquia formation is well exposed in molding sand pits on the east bank of Almond Creek just southeast of Rocketts, where the thickness is 15 feet from Patuxent to Calvert contacts. The material is gray and greenish sand mottled with buff.

It contains a small amount of clay. At the base for about a foot it is filled with gravel. This material appears again a quarter of a mile farther down the creek and on the same side in a pit by the side of the road which passes through the brickyards and joins the Osborn Road. This exposure can be traced at intervals down the east bank of James River, but lies back some distance in ravines heading in the plateau. There is a sand near the top of the bank at the brickyards on Maury Street near Fourteenth in Manchester which is very like the Aquia in appearance.

CHESAPEAKE GROUP

CALVERT FORMATION.

General relations and character.—The plateau at Richmond and to the north, east, and southeast is underlain by the dark clay and sand of the Calvert formation, the only formation of the Chesapeake group which is present in the Richmond area. Its western margin lies under the Lafayette formation along a line extending north from Hollywood Cemetery and passing near the Hermitage Road. Along its western edge it overlaps on to the granite, but to the east it lies on the Aquia formation. It also thickens greatly to the east, for in a well at the Jefferson Hotel it is 75 feet thick, in Church Hill tunnel it is 85 feet thick, and in the region south of Gillis Creek it exceeds 80 feet. The general relations are shown in the section in Plate I. Its base is at an altitude of 150 feet in Brook Run, northwest of Brook Hill, at 80 feet at foot of Pine Street, 62 feet at Jefferson Hotel, 55 feet on Williamsburg Avenue near Thirtieth, 50 feet on Gillis Creek, and 30 feet on south bank of Almond Creek, but it appears to rise slightly farther south. The small showing of the formation which appears in the cut of the Belt Line Railroad, one-half mile northwest of Clopton, is at an altitude of 175 feet.

The most extensive exposure of the Calvert formation is in the steep slopes of the valley of Shockoe Creek, beginning at Franklin Street and extending continuously far to the north and west up the main valley and its branches (Pl. III, *B*). Its basal contact on the Aquia formation is above the valley bottom to Seventh Street, where the top of the latter formation passes underground. It extends up Bacons Quarter Branch to a point within a few yards of the city boundary at Lombardy Street, where its top passes beneath the conglomerate at the base of the Lafayette formation. Apparently it rises again from beneath this conglomerate and is exposed in the creek at two or three points about one-quarter of a mile east of the crossing of Hermitage Road. There are extensive exposures of the formation along the east slope of Shockoe Valley and extending along the base of the plateau on which Chimborazo Park is situated into Gillis Creek valley. Some of the largest outcrops are at Twenty-

first and Grace streets, Twentieth and Marshall streets, and along Lester Street and Williamsburg Avenue east from Twenty-seventh Street.

The principal material is dark-gray clay, which merges into deposits of very fine laminated sand of buff color. In the lower beds there is an admixture of diatom remains in variable proportions, notably at a horizon from 5 to 20 feet above the base. Some of the material contains so large a proportion of these diatoms that it may be classed as "diatomaceous earth," which has some economic value. In its unweathered condition the clay of the Calvert formation varies in tint from pale dove color, through lead gray, nearly to olive green. On weathering, various shades of color result. The portions rich in diatom remains become nearly pure white, and other portions become brownish gray, yellowish brown, or buff and yellow, depending upon the degree of oxidation of iron and amount of carbonaceous matter. The material is very massive when fresh, but after weathering it shows much banding and lamination. Some of this banding is due to alternations of sandy beds with nearly pure clay. There is considerable iron pyrites in the deposits, and on weathering this gives rise to an acidic iron solution, which in some places stains the beds yellow and in others bleaches out the color to light tints. Much of the clay has a sulphurous odor from this source. Shells and impressions of shells occur in large numbers in most of the beds.

The diatoms occur mainly in a stratum about 20 feet thick, beginning some 4 feet above the base of the formation, and more sparingly higher in the formation. The richer deposits occur mostly in streaks and irregular masses, grading into clay that contains a greatly diminished proportion. It is a mistaken idea that there is a thick continuous deposit of high-grade diatomaceous earth underlying Richmond. In Church Hill tunnel, according to Coryell, the formation is 85 feet thick, and the diatoms were in large proportion 50 feet above the base, whereas the basal and top portions were nearly barren of them (Pl. IV, *A*, and fig. 1).

The diatomaceous member is overlain by 20 to 50 feet of gray clay containing sand in general admixture and in varying proportions in different beds, but the character of this material is exceedingly variable. The following description of the formation, especially the diatom-bearing member, is from the report of W. B. Rogers, as State geologist of Virginia for 1840:

> The material in question [diatomaceous earth], composing a thick stratum between beds of sand and clay, is more or less mingled with them, particularly in the vicinity of its bounding surface. But throughout most of its thickness it presents a very fine texture, admitting of being bruised by the fingers into an almost impalpable powder, and singularly free from gritty particles. Its color is a very light gray to white, but the fragments into which it spontaneously divides at the exposed surface of the stratum often present externally a slight ocherous tinge. It is decidedly, though sometimes

indistinctly, laminated, the planes of the thin flakes or sheets being horizontal. When moistened, it displays considerable tenacity, and hence has hitherto been regarded as a fine clay or fuller's earth. Of all its peculiarities, however, capable of being readily discovered, its great lightness is the most extraordinary and characteristic. When quite free from moisture, a pure specimen has a specific gravity of only 0.33, or one-third the weight of water, bulk for bulk.

It is composed almost entirely of microscopic remains of numerous forms of diatoms and rhizopods, many of which are round or oblong disks or cylinders. The former are mostly from one one-hundredth to one six-hundredth of an inch in diameter, and the latter from one three-hundredth to one four-hundredth of an inch long and one twelve-hundredth to one sixteen-hundredth of an inch in diameter, but there are numerous smaller ones. They are marked with many intricate features or divisions of the most remarkable delicacy of form. The number of individuals in a cubic foot is many millions.

This stratum shows itself at nearly the same level on the hillside and in the ravines on both sides of the valley of Shockoe Creek and may be traced on the Shockoe Hill side of the valley without interruption as far as the crossing of the Hanover Road toward the head of the valley and near Turner's mill. From a point on the slope of Church Hill a little beyond Butchertown, commanding a view of the hills and ravines from the poorhouse down, it is easy to trace the broad belt of this deposit by its surface being comparatively deprived of herbage and presenting a white and barren aspect. The thickness of the stratum varies at different points from 12 to 25 feet, the most striking exposures being those met with in the ravine behind the Monumental Church and that between Col. Ambler's and the French Garden. The same or a very similar order is observed in the exposures visible on the opposite side of the valley along the slope of Church Hill. At the bottom of the ravine we see the upper portion of the Eocene and over this the infusorial stratum showing itself plainly and of great thickness at the following points:

1st. Just back of Butchertown on the two roads that extend up the hill.

2d. At the foot of the abrupt base bank which has been cut into north of Main Street on Church Hill and thence south nearly to the next street.

Indeed, along the slope of Church Hill, on the other side of the valley, this stratum may be found in all the ravines and cuttings at the proper level.

Above the infusorial stratum are lead-colored and ocherous sands and clays sometimes nearly resembling it in color but readily distinguished by their greater heaviness. Those which belong to the Miocene division of the Tertiary are remarkable for containing near and for some distance above the infusorial stratum numerous vegetable markings of a vague description, as well as many well-defined impressions of leaves and stems; and toward the top impressions of scallop shells (*Pecten*) and other Miocene fossils. Among the numerous points at which these strata are exposed, the following may be mentioned as interesting and easy of access:

1st. On Governor Street as you descend Main Street, where the impressions of shells are very numerous.

2d. The steep bank opposite the synagogue. Here the clays near the base abound in vegetable impressions, among which are admirably defined leaves. Toward the top the more sandy material contains impressions of pectens.

3d. On Church Hill back of Mr. Van Lew's garden and the bare bank exposed along the valley side of the hill behind Mr. Greaner's dwelling. The base of this bank is on a level with the top of the infusorial bed.

A section in the principal ravine on the west side of the valley of Shockoe Creek is given as follows by Rogers:

At base 3 feet of "lead-colored heavy clay with greenish tinge," then 20 feet of infusorial stratum, 6 feet of greenish-brown and lead-colored clays with vegetable impressions, and 14 feet of more sandy stratum of mottled gray and yellowish-brown vegetable impressions and prints of pectens. In a later description by Rogers, in 1859,[1] he stated that the "infusorial deposit" varies in thickness from 20 to 30 feet on the north side of Shockoe Creek valley and 50 feet on the Church Hill side. It is separated from the Eocene by a thin deposit of whitish and sometimes ocherous clay mingling toward the top with the lighter material of the infusorial stratum. The beds overlying the latter are a series of strata consisting of various intermixtures of clay and sand, of which the lower is generally a compact, light-colored clay, the next a bluish or grayish, more arenaceous mass, and the uppermost an argillaceous stratum of light-brown and mottled appearance. The total thickness of this series is about 25 feet. There are many fossils, among the most common of which are *Fusus quadricostatus*, *Panopæa reflexa*, and Miocene species of *Pecten*, *Arca*, *Crassitella*, *Cytherea*, *Venus*, *Astarte*, *Turritella*, etc. In the lower dark-colored stratum are "stems and woody pieces which from microscopic indications seem to be coniferous, while on the argillaceous layers both beneath and above are prints of dicotyledonous plants." The diatoms are microscopic forms of plants which live in salt water as well as fresh, and have the power of secreting silica to form their shell or test. When the plant dies these minute structures of silica accumulate on the bottom, but undoubtedly a very long period was required for the formation of the thick beds which we now find, especially the purer layers, which have but little admixture of clay or sand. The diatom tests are very beautiful objects under the microscope.

List of diatoms.—Stodder has given a list of the species of diatoms from various horizons from samples collected in a ravine on the west side of Shockoe Hill.[2] Four horizons were selected—the first, 5 feet below the surface of the exposure; the second, 11 feet below; the third, 14 feet below; and the last on the north side of the ravine "40 feet below the top, from a bed apparently the continuation of the 14-foot bed on the opposite side, the hill being higher on the north side." All the specimens are similar in appearance excepting those from the lower bed, which are much darker. The material is very like clay, of light-drab color and very low specific gravity. The upper bed has a smaller proportion of diatoms, about 20 per cent, but they are in more perfect condition, whereas in the deeper beds they are more broken. The lower layers contain 50 to 80 per cent of organic forms, of which diatoms constitute by far the greater part. The other

[1] Proc. Boston Soc. Nat. Hist., vol. 7, 1861, pp. 59-64.
[2] Idem, vol. 18, 1877, pp. 206-209.

material is clay and fine silt. The following table shows distribution of species, and it will be noted that the principal difference is in the upper or 5-foot layer, for it lacks many of the genera or species of the lower strata:

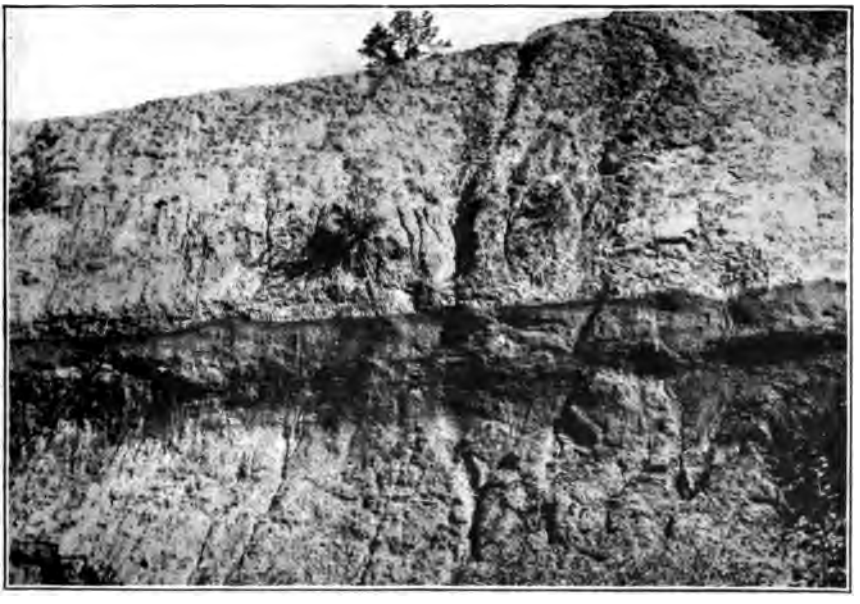
Diatoms in the Miocene deposit at Richmond, Va.

	5 feet.	11 feet.	14 feet.	40 feet.
DIATOMACEÆ.				
Actinoptychus senarius		×		×
biternarius	×	×		
Omphalopelta punctatus	×	×		
versicolor		×		
Actinocyclus ehrenberghii			×	
Coscinodiscus radiolatus		×		
punctatus, oval and spherical varieties	×	×	×	×
lineatus		×	×	
velatus	×	×		
marginatus	×	×		
radiatus		×	×	
gigas	×	×	×	×
oculis-iridis	×	×	×	
perforatus	×			
centralis			×	
subtilis		×		
Systephania corona		×	×	×
Aulacodiscus crux	×			
Craspedodiscus coscinodiscus	×	×	×	×
Asterolampra brebissonii Greg		×	×	
Eupodiscus rogersii	×			
Endictya oceanica				×
Pyxidicula aculeata		×		
Stephanopyxis diadema		×		×
apendiculata		×	×	
Xanthiopyxis globosa		×		×
hirsuta		×		
oblonga				
Rizosolenia americana	×	×	×	×
Goniothecum odontidium	×	×	×	×
rogersii	×	×	×	×
Dicladia capreolus			×	
Chætocero sp		×		×
Biddulphia toumeyii	×	×	×	×
Triceratium reticulum		×		
undulatum		×		
condeconum		×		×
obtusum	×		×	×
marylandicum		×	×	×
Mastogonia actinoptychus	×			
Rhaphoneis amphicerus		×		
Grammatophora marina		×		
africana		×		
Navicula (Pinnularia) perigrina		×	×	
viridis		×	×	×
Navicula viridula				×
Pleurosigma= Nav. sigma Eh., very like P. angulatum		×	×	×
Stephanogonia polygonia		×		×
Orthosira marina W. S.= Galionella sulcata Eh	×	×		
Fragilaria pinnata		×		
RHIZOPODS.				
Actiniscæ:				
Actiniscus pentasterias	×	×		
Dictyocha crux	×			
fibula	×			
Mesocenia diodon	×			
Polycistinæ, various	×			×
Phytolitharia Eh., Spongolithis acicularis, S. caputserpentis; spines of Polycistinæ, Acanthometra and others	×	×	×	×

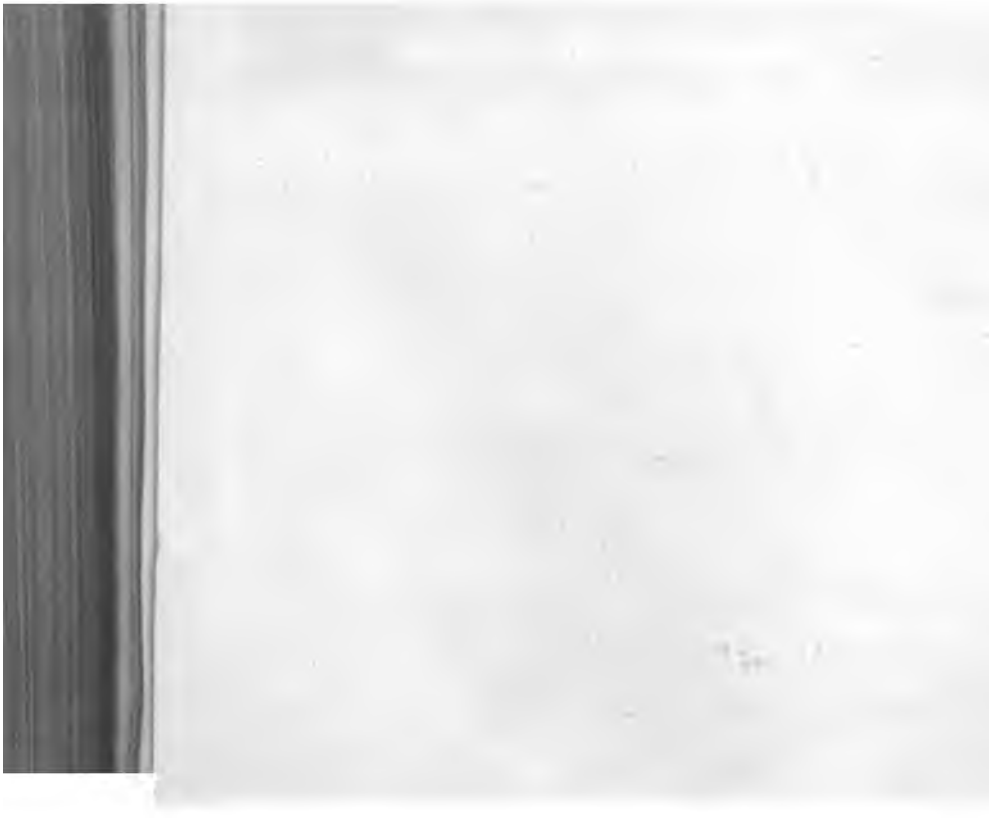
It has not been thought advisable to attempt to identify all of Ehrenberg's species, as his plan was to found a species upon any variation in the number of rays in the circular forms of the Diatomaceæ, a principle now generally rejected.

One striking fact is the great abundance in all the layers of *Galionella sulcata* Eh.= *Orthosira marina* W. Smith, which is more numerous in some slides than all the other forms together.

A. CALVERT FORMATION IN CUT NEAR ELEVENTH AND TURPIN STREETS, RICHMOND, VA. DIATOM-BEARING CLAYS.



B. CONTACT OF CALVERT AND AQUIA FORMATIONS IN GULLY AT TWELFTH AND LEIGH STREETS, RICHMOND, VA. LOOKING SOUTH.



Basal contact.—The contact of the Calvert and Aquia formations is exposed at many places along the west side of Shockoe Valley from Seventh Street crossing to Broad Street, and although not everywhere equally distinct there is marked unconformity throughout. The top of the Aquia formation is irregularly eroded and faintly channeled with depressions in places an inch or two deep. Some of the dark sand of the Aquia formation is mixed with the first deposits of the Calvert formation.

An exposure of the contact beginning a few yards northwest of the intersection of Leigh and Thirteenth streets extends into the gully a few rods north of there and thence for some distance along the foot of the slope by Twelfth and Turpin streets. (See Pl. IV, *B*.) Near the top of the Aquia formation is a hard layer, in part ferruginous, 3 to 5 inches thick, grading up into 2 feet of dark-gray sand with considerable clay admixture. On the irregularly eroded surface of the latter lies the base of the Calvert formation, a gray clay with many dark sand grains and scattered quartz pebbles. In places where the basal Calvert contains much dark sand, the contact is not very distinct.

In the cut of the Seaboard Air Line Railway, on the west side of Shockoe Creek near the line of Eleventh Street, the contact is exposed for 125 feet about 10 feet above the tracks. It is somewhat indistinct owing to the dark color and sandy nature of the basal member of the Calvert formation for about a foot above the contact. Many scattered pebbles occur in the deposit, and it weathers lighter than the underlying Aquia formation. At the top of the latter are 2 feet of dark sand, grading down into a hard layer 8 inches to 1 foot thick, which weathers to a buff or yellow color. In this vicinity the diatoms extend down to within a short distance of the contact apparently because the plane of contact rises somewhat. There are extensive exposures of the Calvert and underlying beds in the large gully from the west which empties into Shockoe Creek near Eleventh and Balding streets. The basal contact is clearly exhibited and the diatom-bearing deposits extend nearly to the base of the Calvert formation. At the base there is, as at other places, considerable sand and scattered pebbles. The contact plane presents many small irregularities and in general it shows a slight rise to the north and west probably some of it crossing the Calvert strata.

The Calvert-Aquia contact crosses Shockoe Creek just above the line of Seventh Street somewhat above the main forks of the creek, but it is covered by filling. It is well exposed for about 100 yards in a gully on the west side of the valley a few rods south of this place or on a line with Eighth Street. Here it is particularly distinct, for at the top of the Aquia formation is 12 feet of dark-colored sand and the plane of contact is notably irregular. The gully is cut deep

into overlying Calvert beds which are diatomaceous down nearly to their base. The basal bed is sandy and contains many small scattered pebbles of quartz and grains of glauconite.

The Calvert formation and its basal contact are well exposed at the southeast end of Main Street at its junction with Williamsburg Avenue at Twenty-eighth Street, and extending around the south end of the high bluff to the old railroad tunnel. The contact is 8 feet above the street grade at Thirtieth Street and Williamsburg Avenue, or at about 55 feet above sea level. The brown and green mottled sands of the Aquia formation are planed off nearly smooth, and on them lies a thin deposit of clay containing sand layers and streaks and considerable ironstone. Some brecciated masses of clay occur in this layer. Next above is a 4-foot bed of very stiff blue-gray clay grading sharply into compact clays containing a large proportion of diatom remains, of which 50 feet or more are exposed up

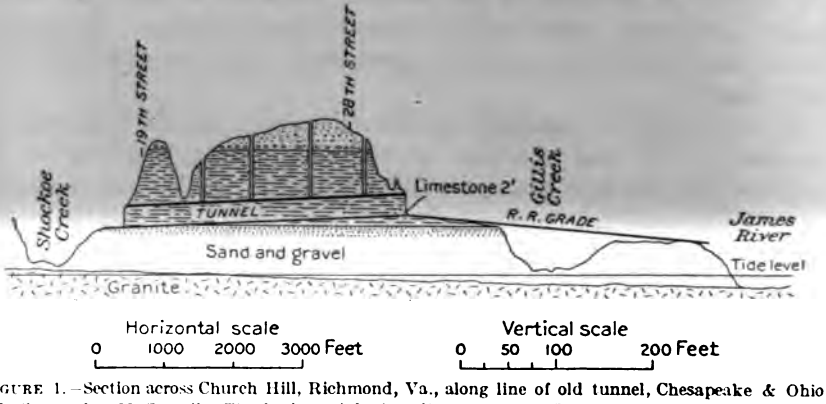
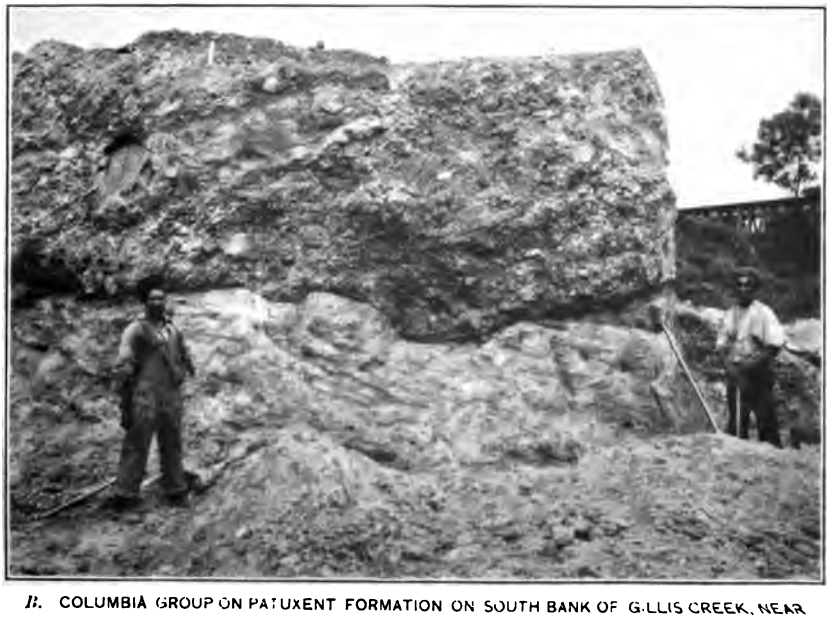


FIGURE 1.—Section across Church Hill, Richmond, Va., along line of old tunnel, Chesapeake & Ohio Railway after M. Coryell. The horizontal broken lines represent Calvert formation; the overlying material is Lafayette gravelly orange sand; below is Aquia sand lying on Patuxent sand and gravel.

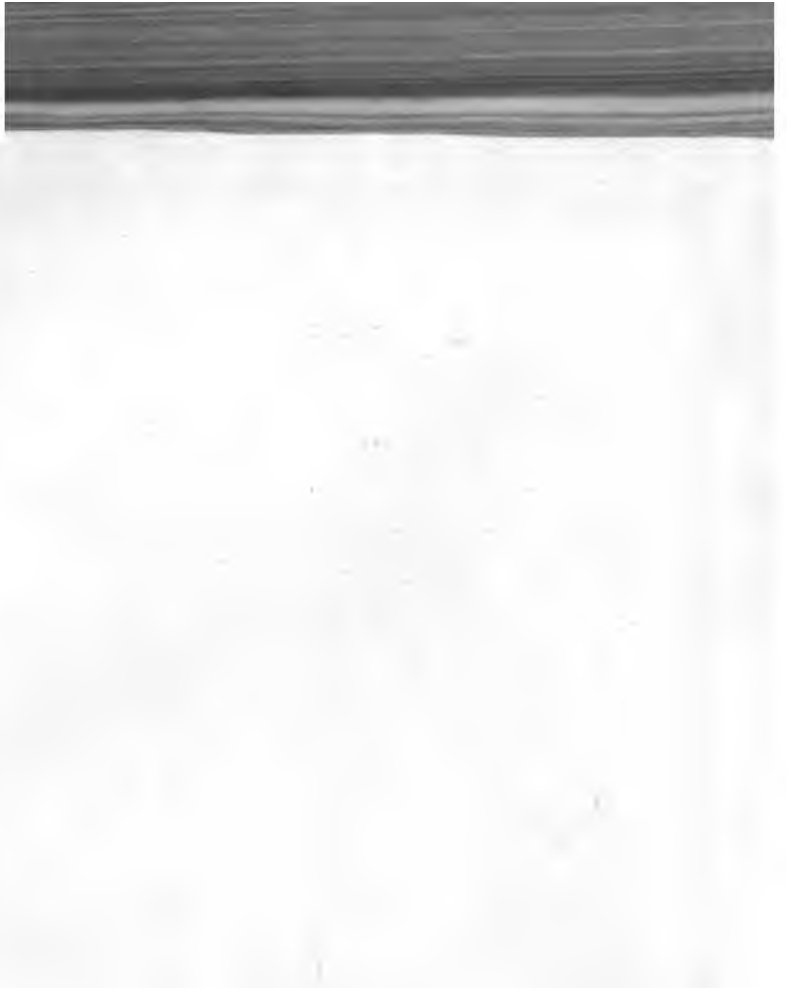
to the capping of Lafayette formation on the plateau. Williamsburg Avenue rises very nearly to the base of the Calvert formation at Thirty-first Street, apparently within 2 feet. The contact extends eastward and then north up the depression followed by the old line of the Chesapeake & Ohio Railway to a point within a few yards of the mouth of the tunnel. It is very smooth, has slight local irregularities, and dips gently to the east at a very low rate. The basal bed is a dark, tough, sticky clay about 4 feet thick. Its basal portion contains some gray sand and glauconite grains from the underlying Aquia formation. The old tunnel is entirely in the basal portion of the Calvert formation, as shown in figure 1.

The formation is largely exposed on the north side of the valley of Gillis Creek in banks 10 to 50 feet high. The material is dark clay containing diatom remains which are in considerable proportion in some beds. The richly diatomaceous material weathers out in soft

A. CALVERT FORMATION ON GRANITE ON NORTH BANK OF JAMES RIVER, NEAR FOOT OF PINE STREET, RICHMOND, VA.



B. COLUMBIA GROUP ON PATUXENT FORMATION ON SOUTH BANK OF GILLIS CREEK, NEAR ITS MOUTH, RICHMOND, VA.



chalky masses of light weight and nearly pure white color. The basal contact is exposed just north of the National Cemetery Road in the bed of a small creek near the line of the prolongation of Broad Street or just west of the point where that road crosses Gillis Creek. The contact is near the level of the road. The Calvert formation is well exposed on the south side of the valley from the National Cemetery Road northward and they extend down to the creek a short distance west of the main road crossing at the mouth of Stony Run.

Western margin.—The western margin of the Calvert formation extends across the edges of the Aquia and Patuxent formations, as shown in the section in Plate I, to an irregular line extending along the east side of Hollywood Cemetery and near the Hermitage Road to a point not far west of Brook Hill. Possibly in the higher part of the western portion of Richmond it extends some distance west of the line, as far even as Acca. There are exposures of the thin edge of the formation lying on granite in the railroad cuts on the north bank of the river at the foot of Pine and Laurel streets. A view of a portion of the exposure is shown in Plate V, *A*.

The material at this place is fine, loamy sand containing a few pebbles and quartz fragments in its basal portion. The thickness is about 6 feet. The contact is very irregular, being marked by channels or pot holes, one of which is shown in Plate V, *A*. Nearer Pine Street there is considerable gravel in the basal part. The formation thins out to the west, but owing to the presence of talus it was not possible to locate its margin; it may extend into Hollywood Cemetery back some distance from the river. The formation thickens to the east and 20 feet appear in the bank near the foot of First Street. It was formerly exposed in the steep slopes of the park just opposite, and it is penetrated by the railroad tunnel under Byrd Street between Third and Fourth streets.

The formation was penetrated by the well at the Hotel Jefferson, of which the following record is given:

Record of well at Hotel Jefferson, Richmond, Va.

	Feet.
Soil and gravel (Lafayette)	0–43
Yellow clay	43–45
Black clay	45–75
Sand	75–90
Sand with shells and a little water	90–102
Blue clay	102–118
Soft granite	118–123
Hard and soft granite with water at 410 and 438 feet	123–445

The Calvert and overlying Lafayette formations are 98 feet thick at the brewery on the corner of Harrison and Clay streets, where a well reached the granite at that depth.

The cuts of the Ashland Railroad just northwest of Brook Hill expose 50 to 60 feet of the Calvert formation, part of which consists of fine buff sand in layers. A mile farther north, on the north side of Brook Run, material of this kind extends down to the granite, although there is slight possibility that some of it may be Aquia.

The Calvert formation is exposed at intervals along the slopes of the highlands on the south side of the Chickahominy Valley. One notable exposure of 30 feet of beds is in a gully below the dam of a pond 1¼ miles southeast of Huntslet. Many fossils occur at this place.

Outlier south of Manchester.—The typical gray clay of the formation is exposed for a few rods in a cut of the Belt Line Railroad half a mile west of Clopton. It is the top of a low mound which rises 8 feet above the railroad under a heavy mantle of Lafayette formation. This formation may underlie an area of considerable extent in the ridges southwest of Manchester, but at all other points the Lafayette appears to come down to the granite or to the level of the upper edge of deposits of the Columbia group to the east.

Analyses.—An analysis of material collected by H. Ries[1] from Seventh Street near the locomotive works is as follows:

Analysis of clay of Calvert formation at Richmond, Va.

[Made at Virginia Polytechnic Institute.]

	A	B
Silica (SiO_2)	70.42	63.17
Alumina (Al_2O_3)	15.15	19.30
Iron oxide (Fe_2O_3)	5.17	6.32
Lime (CaO)	.14	.06
Magnesia (MgO)	.79	.69
Potash (K_2O)	2.24	2.45
Soda (Na_2O)	.39	.09
Titanic oxide (TiO_2)	.44	.88
Loss in ignition (H_2O, etc.)	5.21	6.39
	99.95	99.35

The material of sample A was somewhat weathered and contained but few diatoms. Sample B was collected from the same locality but deeper in the bank. The weathered material was much more siliceous and contains a small amount of fine particles and soluble substances due probably to the action of water on the exposed surface.

Another analysis of the diatom deposits from Shockoe Creek valley was made by J. M. Cabel in 1884[2] at the State University. The sample was collected from the middle of the bank just below the colored normal school on President Hill and consists almost entirely of diatoms. It was white with a tinge of yellow, and a mass of it covered with varnish had specific gravity .922. The specific gravity of the powder was 2.321.

[1] Preliminary report on clays of Virginia: Bull. Virginia Geol. Survey No. 2, 1906, p. 143.

[2] University of Virginia University Notes, 116; The Virginias, vol. 6, 1885, p. 3.

Analysis of diatom deposit at Richmond, Va.

Silica (SiO_2)		75.68
Alumina (Al_2O_3)		9.88
Iron oxide (Fe_2O_3)		2.92
Lime (CaO)		.29
Magnesia (MgO)		.69
Potash (K_2O)		.02
Soda (Na_2O)		.08
Nitrogenous matter (N×6)		.84
Water (by H_2SO_4)	3.37	
Water at 100° C	1.17	
(Less N) by ignition	3.83	
		8.37
		98.77

On boiling in 20 per cent solution of sodium hydrate it was found that somewhat more than one-third of the silica was dissolved; a small additional amount dissolved in another hour and over 50 per cent remained insoluble.

LAFAYETTE FORMATION.

General relations and character.—The plateau surface lying between the larger valleys of the Coastal Plain is covered by a thin sheet of Lafayette formation which also extends westward into portions of the Piedmont province. It consists of sand, gravel, and loam, mostly of pale orange tint, about 30 feet thick. Its surface is remarkably smooth and it mantles unconformably an equally remarkably smooth eroded surface of the older formations. In the Richmond region it lies on the Calvert formation to the east and overlaps on to the granites to the west. It slopes to the east at a rate of about 5 feet to the mile in the eastern part and 20 feet or more to the mile in the granite region. It also slopes down into the larger drainage basins, which evidently were outlined before the deposition of the formation. This local downward slope is well exhibited in the ridge next south of Gillis Creek east of Rocketts and in slopes west of Clopton and along James River above Richmond and Manchester.

The Lafayette formation has been removed along the valleys of James and Chickahominy rivers and their affluents. The smaller branches of the lesser creeks, however, head in the formation and there are wide areas on the divides where the plateau is not incised by drainage and the run-off is sluggish or imperfect and there is considerable seepage underground.

Exposures.—There are some excellent exposures of Lafayette deposits in gravel pits in the north slope of the valley of Bacons Quarter Branch, one-fourth mile beyond the city boundary (Lombardy Street). The cuts show 10 feet of the formation. The upper 3 feet is red loam, which grades down into gravel and coarse buff sands, partly arkosic. Pebbles nearly an inch in diameter predominate, 5

per cent being 2 inches and a few as much as 4 inches. All the pebbles lie flat and the deposit has an obscure bedding. Some are white, others more or less deeply stained orange. Quartzite predominates, but some pebbles and bowlders are quartz and a very few are granites and other crystalline rocks. The red loam at the top thickens to the north and shows pebbly streaks. At one place it is underlain by a layer of gray clay 20 inches thick, pebbly at the base but giving place abruptly to the gravel bed below. In part of this exposure the gravel bed is banded in lighter and darker buff-brown and pinkish tints of varying thickness and continuity. Here the base of the formation is coarse brown conglomerate lying on an irregular surface of the Calvert formation. It appears in the creek just east of Lombard Street and again at a point halfway between that street and Hermitage Road crossing. Fine exposures of the Lafayette are presented just south of the point where Hermitage Road crosses Bacons Quarter Branch.

There are numerous deep cuts in the Lafayette formation in the plateau on the east side of Shockoe Valley, notably at Marshall Street and Twentieth and Twenty-first streets, where the lower member, 8 to 15 feet thick of sand and gravelly sands, grades up into an upper member of orange loam. In the shafts descending to the old Church Hill tunnel the formation was 30 feet thick according to Coryell[1] (see fig. 1, p. 24), and in the well at Hotel Jefferson it was 43 feet to the base of the gravel, lying on yellow clay of the Calvert formation.

The long cuts of the Chesapeake & Ohio Railway through the divide northeast of Highland Park present extensive exposures of the Lafayette formation. The principal material is an orange loam, some portions having a buff tint. It is mostly fine grained, but the lower beds contain much gravel. The cuts of the Ashland Railroad near Brook Hill are in Lafayette formation for some distance. The material is orange loam, gravelly at the base. There are deep cuts in the formation along the Belt Line Railroad on both sides of James River. The deepest cuts begin near Clopton and extend west for more than a mile. In places they are 30 feet deep. The material is the common sandy loam of orange tint, but there are many irregular streaks of gravel and some clay. There is much crossbedding of the coarser materials and local unconformities. The changes in character of sediments are numerous and abrupt. That the orange tint is deepened by weathering is plainly shown in one cut through a rounded knoll, where the deeper orange tint extends to a depth of about 6 feet and curves closely parallel to the surface. There are very instructive cuts along the Belt Line Railroad a short distance north of the bridge

[1] Coryell, Martin, Diatomaceous sands of Richmond, Va.: Proc. Am. Inst. Min. Eng., vol. 4, p. 230; The Virginias, vol. 2, 1881, pp. 6-7.

over James River. There the Lafayette lies on the crystalline rocks with many irregularities of contact and variations in composition. The upper part is a bright orange sandy loam; lower down are streaks and lenses of gravel exhibiting much cross-bedding. Half a mile northeast is the yard of the West End Brick Co., where there is an extensive exposure of the orange sandy loam which caps the plateau on which Richmond is built. At the top is 6 feet of bright orange red loam. It grades down into mottled buff and red loam. A view of this exposure is given in Plate X, *B*.

The Lafayette formation mantling the plateau west of Manchester presents its common characteristics of orange sand or loam with more or less gravel intermixed. The top member is an orange-tinted sandy loam from 3 to 6 feet thick. The most extensive exposures are those above mentioned along the Belt Line Railroad. There are cuts also on Semmes Avenue near Twenty-fourth and Twenty-fifth streets, exposing 6 feet of bowldery orange loam with pebbly streaks lying on decomposed granite. Some of the bowlders are a foot in diameter.

COLUMBIA GROUP UNDIFFERENTIATED.

The terraces in the lower part of Richmond and along James River southward are occupied by loams, sands, and gravels of the Columbia group, which also floors the valley of Chickahominy River and extends up the valleys of Shockoe, Gillis, and Almond creeks. The thickness of most of the deposits ranges from 20 to 30 feet and the altitude ranges from sea level to slightly over 100 feet.

There are remains of two terraces of the Columbia group in the south central part of Richmond. The higher one, with an altitude of about 85 feet, constitutes a very distinct bench occupied by the old canal basin and Byrd Street depot. It may extend to the corner of Main and Twelfth streets and on Canal Street it extends almost or quite to the corner of Seventh Street. The deposits are well exposed on Seventh Street between Byrd and Brace streets and on Tenth Street above and below Byrd Street. Deposits of the Columbia group at a lower level are exposed in the east end of the inclosed yard of the Tredegar Iron Works, at the foot of Seventh Street. The altitude here is about 50 feet, and 8 feet of gravelly sand are exposed, in part stratified. Considerable sand lying on granite on the east end of Mayo Island is probably post-Columbian.

A wide area of deposits of the Columbia group extends along the east side of Shockoe Creek valley and thence along the river bank to Thirtieth Street. Main Street traverses them from the creek crossing nearly to Twenty-seventh Street. They constitute a sloping plain which rises to an altitude of 77 feet at the corner of Main and Twenty-sixth streets and terminates in a low bluff with an altitude of 28 to 40

feet just south of Carey Street from Nineteenth to Thirtieth Street. This bluff exposes buff sandy loam with pebbly streaks lying on the Patuxent formation and near Twenty-fifth Street on the Aquia formation. In the deep cut of the Chesapeake & Ohio Railway at Rocketts Street the Columbia lying on the Patuxent is a buff loam with sandy layers and pebbly streaks, its top being about 44 feet above sea level. A narrow strip of the terrace extends along the south side of Williamsburg Avenue in the vicinity of Thirty-first and Thirty-second streets, rising nearly to an altitude of 50 feet. Near the bank of Shockoe Creek at Turpin and Thirteenth streets is a small mass of deposits of the Columbia group. It has been dug for gravel and consists of sand and gravel irregularly intermixed or interbedded.

Columbia deposits are well exposed, capping the 40-foot bluff which extends along the river bank from Rocketts nearly to Almond Creek. At the top are 3 to 4 feet of brown loam, which thickens to the east and is extensively worked for brick clay on the flat terrace extending to the base of the hills. Next below is a gray loam containing scattered pebbles and lying on brown sand which rests on the Patuxent formation.

There are long exposures in the railroad cuts in the southern part of Rockets, where the Columbia group lies on the arkosic sands of the Patuxent formation. The lower beds contain a large number of bowlders, some of them 3 to 4 feet in diameter, derived from many kinds of rocks, including granites, gneiss, quartzite, and other crystalline rocks, and sandstone. This member grades upward into sand and sandy loam 10 to 20 feet thick.

There are three terraces of the Columbia group on the west side of James River east and southeast of Manchester. The first is the freshet plain, the second is about 20 feet higher, and the third is 30 feet still higher. The first two are flat, but the surface of the highest one is rolling. Granite appears in the steeper slopes and juts up at intervals in the terraces.

In the railroad cuts near the intersection of Semmes and Cowarden streets the Columbia group capping decomposed granite is well exposed. It is 8 to 10 feet thick and consists of gray gravelly loam. At Seventh and McDonough streets there is a 20-foot cut in fine brown loam containing very few small streaks of gravel; this loam was at one time worked for brick clay. At McDonough and Fifth streets the railroad cut exposes granite capped by brown loam with many bowlders and pebbles.

The Columbia deposit near Goode Creek lies on granite. It is a loam with pebbly streaks and has many bowlders in the basal portion. It extends west at an altitude of 110 to 115 feet to the Atlantic Coast Line Railroad where there is a rapid rise to the Lafayette plain.

A fragment of a Columbia terrace extends up the small branch of Gillis Creek, which empties a few rods west of the point where the National Cemetery Road crosses that creek. The beds constitute a small, narrow flat and end upstream with sharp boundaries on adjoining slopes at about 80 feet above sea level. The Columbia group extends up Gillis Creek valley in a terrace nearly one-quarter of a mile wide, but the deposits are cut through nearly as far as the Charles City Road crossing, where there is a wide flat. The Columbia group extends some distance up Stony Run valley, where two faint terrace levels are presented.

ECONOMIC GEOLOGY.

GRANITE.

GENERAL CHARACTER.

The massive granite which comes to the surface over a large area in the western part of Richmond is in greater part well suited for building stone of the highest grade and the supply is inexhaustible. It has been quarried extensively for many years and furnished most satisfactory material for a large number of buildings in Richmond and elsewhere. One of the most notable structures built partly of it is the State, War, and Navy Department building in Washington, the rock for which came from the Westham quarries. The granite is of bluish-gray to light-gray color, remarkably uniform in composition and texture, and free from minerals which cause staining or decomposition. Like most granites it darkens somewhat on long exposure to the weather. The rock is so massive that blocks of the largest sizes can be worked, and large bodies of it are so free from irregularities in texture or color that dimension stone which will match perfectly may be obtained in any quantity desired. There are two principal varieties—one a light-gray rock of moderately coarse grain, which is used for building, and the other a finer-grained, darker, bluish-gray rock, which is selected for monumental work. Nearly all of the granite is jointed in such a manner that it can be worked with great convenience and the presence of heavy flat jointing or "sheeting" is especially advantageous. Ordinarily the joints are so widely spaced that they cause but little waste in quarrying. The surface of the granite is decomposed to a moderate extent in most parts of the area, but the depth to solid rock is seldom greater than 5 feet. In some localities the unweathered granite is found at the surface. The amount of cover or "overburden" varies greatly with the locality. On the high plateau surfaces the covering of Lafayette formation may be 30 feet thick, but on the slopes of the larger depressions the granite comes almost or quite to the surface, and but little stripping is necessary. In places the granite is cut by

narrow dikes of pegmatite and some portions contain knots of darker or lighter rock, but these materials affect little of the stone.

QUARRIES SOUTH OF JAMES RIVER.

There are 23 large quarries in the vicinity of Richmond, but some of them are not in operation and most of those that have been abandoned are full of water. Some details regarding quarries have been published by Watson.[1] Views of several representative workings are shown in Plates VI to VIII, which illustrate the conditions of quarrying, the nature of the jointing, and other features of the industry.

Granite station on the Richmond & Danville branch of the Southern Railway, about 4 miles west of Richmond, is an important center of the granite industry. A few rods north of the station is a large quarry now worked by Alvin Netherwood for building stone, paving blocks, and crushed stone. About an acre of the granite has been stripped and excavated to a depth of 30 feet. The present working faces are 250 feet long on one side of the quarry and 125 feet long on the other. A large amount of dimension stone is being produced for shipment to various places. The rock is jointed into very thick, nearly horizontal sheets, and there is also vertical jointing at various intervals, which features facilitate the excavation of large blocks. Most of the granite is of light-gray color, moderately coarse texture, and uniform tint, so far as can be judged by the fresh material. A few rods north is the old State quarry, not now in operation. There are two deep openings, one of them 600 feet long and 200 feet wide. It is stated that material for the present Richmond post office was obtained at this quarry. The granite, which is of medium tint and texture, presents the usual heavy horizontal jointing as well as vertical joints and is cut by a few small pegmatite dikes. Watson found a mass of banded gneiss in the lower side of the larger opening, but its relations are not exposed.

A short distance southwest of Granite station are several large quarries, among them the Mackintosh and the Middendorf. The former is probably the largest quarry now being worked in the State. The working area is about 2 acres and a portion has been excavated to a depth of 40 feet. There is a nearly horizontal jointing, which gives the rock a bedded structure favorable for quarrying and also numerous nearly vertical joints trending about N. 10° W. and N. 65° E. In places considerable stripping is necessary. The quarry is equipped with machinery for large output of dimension stone and the material is of most satisfactory quality and appearance. Most of it is of moderately light color and grain, but there is also

[1] Watson, T. L., Granites of the southeastern Atlantic States: Bull. U. S. Geol. Survey. No. 426, 1910.

A. BELLE ISLAND GRANITE QUARRY, FACE AND CRUSHER, FROM NORTH BANK OF JAMES RIVER, IN UPPER RICHMOND, VA.

B. SMITH GRANITE QUARRY, ON SOUTH BANK OF JAMES RIVER, 2 MILES ABOVE RICHMOND, VA.

some of the finer-grained, darker rock. The product of this quarry was used extensively in the State capitol at Richmond.

The Smith quarry, formerly well known as the Netherwood, is an extensive opening on the high south bank of James River, about 2½ miles west of Richmond. It is said to have been in operation for over 65 years. The quarry is about 200 feet long, 200 feet wide, with a working face about 40 feet high. Part of this face is shown in Plate VI, *B*. Two varieties of rock are found—one fine grained and of bluish appearance, used for monumental work, and the other light gray and coarser grained, worked for building stone, paving blocks, crushed stone, etc. As in most of the quarries, there is a nearly horizontal system of joints, dividing the granite into sheets from 2 to 20 feet thick, and a vertical system, trending northeast and northwest, cutting these sheets into huge blocks. Dimension stone of any desired size and of remarkable uniformity in color and texture can be obtained. The fine-grained stone is in a thick vertical mass, which cuts the coarse grained variety, but merges into it in a short distance. Another mass of fine-grained granite in the western part of the quarry is separated by a vertical fault along which the rock is considerably shattered for a few feet on either side. Small streaks of the rock are too coarse grained or pegmatitic for use in building, but this material is utilized for paving blocks or crushed.

Half a mile above the Smith quarry there is a smaller opening known as the Wray quarry, which yields dimension stone and paving blocks of moderately coarse-grained granite of exceptionally good quality. It is on the south bank of the river and slightly above the level of the railroad tracks. The flat jointing is well developed here and the thick sheets of granite dip gently to the southeast. There is widely spaced jointing trending east and west and north and south. The quarry face is about 40 feet long and 30 feet high.

The next quarry on the south bank of the river comprises a series of large openings made by the James River Granite Corporation. It is on the south side of the Southern Railway, half a mile below the crossing of the Belt Line Railroad. The working face is about 110 feet long and 40 to 50 feet high. At the top is about 12 feet of gravel belonging to the Lafayette formation, which has to be stripped. The horizontal jointing is not so well developed here as in some of the other quarries. There are strong vertical joints, mostly trending northeast and southwest. The material is of fine uniform texture and mostly of dark blue-gray color. The rock is cut by numerous dikes of pegmatite and there is a dike of light-colored granite cutting the dark-gray rock in the west end of the quarry. Formerly some excellent dimension stone was quarried here, but now the product is crushed rock for road material and concrete work. This material sells for about $1 a ton, free on board at Richmond.

There are high banks of excellent coarse-grained gray granite extending continuously along the south side of James River below Smith quarry to Manchester, but the rock is not quarried. There is, however, a small old quarry at the south end of the bridge to Belle Island. It has a 30-foot face showing massive coarse-grained granite with considerable variation in color from place to place. The flat jointing is well marked, the joints having low inclination to the southeast, and there are wide-spaced vertical joints.

The ledges on Belle Island have been extensively quarried by the Old Dominion Iron & Nail Works mainly to furnish crushed rock for road material and concrete. The quarry face, 60 feet high, and the crusher are shown in Plate VI, *A*. The horizontal sheeting of the granite is well marked. On the granite there is a cap of gravel and loam belonging to the Columbia group, 5 to 15 feet thick, which has to be stripped. There are two varieties of the rock, one light colored and coarse grained and the other darker colored and finer grained; also scattered pegmatite dikes.

There are two granite quarries south of Manchester—one, now abandoned, on the west bank of James River just below the mouth of Goode Creek, and the other, known as the McGowan quarry, on Broad Branch Run a few hundred yards east of the Petersburg Pike. The McGowan quarry is an extensive producer of granite of exceptionally fine quality used mainly for monuments. The principal working face in the quarry is shown in Plate VII, *A*. The overburden of Columbia deposits and decomposed rock which has to be stripped is about 5 feet thick. The opening is about 125 feet square and 20 to 40 feet deep. The nearly flat jointing is well developed, and the vertical joints are so widely spaced that very large blocks are obtainable. The color and texture of most of the granite are remarkably uniform, and the quarry is capable of producing a large amount of dimension stone.

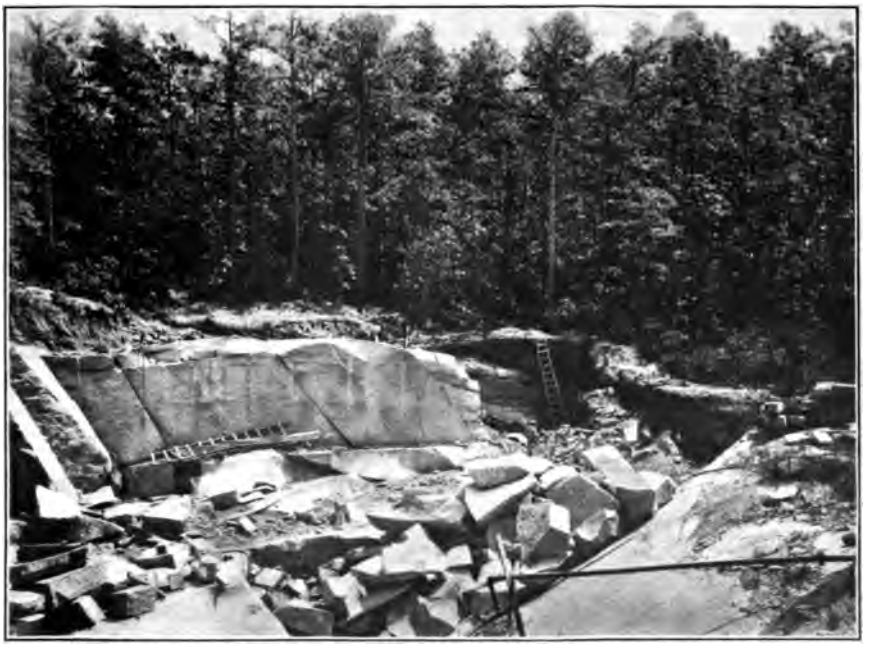
The old quarry on the west bank of James River at the mouth of Goode Creek has been worked largely for riprap and crushed rock. The excavation is about 100 feet long and 30 to 40 feet deep and considerable stripping is necessary. Some of the rock is much broken and cut by pegmatite dikes, but other portions would afford good dimension stone of medium color and moderately fine even grain.

The old Westham and Green quarries, on the south bank of James River a mile northwest of Granite station, are not now in operation. They were extensively worked in years past and show very large working faces of high-grade rock in very thick beds.

QUARRIES NORTH OF JAMES RIVER.

The largest quarries north of Richmond are those of the Richmond Granite Co., on Brook Run a short distance northeast of Morrison

A. McGOWAN GRANITE QUARRY, ON BROAD ROCK BRANCH, NEAR PETERSBURG PIKE, 3 MILES SOUTH OF MANCHESTER, VA.



B. ONE OF THE QUARRIES OF THE RICHMOND GRANITE CO. JUST EAST OF THE RICHMOND, FREDERICKSBURG & POTOMAC RAILROAD, 4 MILES NORTHWEST OF RICHMOND VA. SHOWS DIAGONAL JOINTING.

A. GRANITE QUARRY OF J. A. McCLOY, ON GROVE AVENUE, IN WESTERN PART OF RICHMOND, VA.

B. UPPER CLAY AT DAVIS BRICKYARDS, ON MAURY STREET, MANCHESTER, VA.

station on the Richmond, Fredericksburg & Potomac Railroad. One of the principal openings is shown in Plate VII, *B*, which is near the eastern end of the property. The workings extend for 600 feet along the hill slope, and portions of them are 40 feet deep, so that the amount of granite in sight is very great. There is heavy horizontal "bedding" in part of the area and well-pronounced diagonal joints, trending northeast and northwest, some of which are shown in Plate VII, *B*. Most of the rock is very massive and of uniform texture and color, yielding very high-grade dimension stone of any size desired. There are local developments of irregularly coarse-grained rock, but it does not interfere with the quarrying. A small amount of gravel and sand has to be stripped and some of the surface rock is too much decomposed to be used. Considerable granite from this quarry is cut into paving blocks, and the waste is crushed for concrete and road metal.

The McCloy quarry is on the western margin of the city of Richmond about 500 yards west of the new reservoir. The working face is about 100 feet long and 20 feet high, and there is a thin capping of sand and gravel of the Lafayette formation which has to be stripped. A portion of the workings is shown in Plate VIII, *A*. The rock is fine-grained bluish-gray and generally of uniform composition, texture, and color. The horizontal jointing, so general in the Richmond region, is well developed and there are also wide-spaced upright joints trending in various directions and sloping to different degrees. A moderate amount of dimension and monumental stone of superior quality is now produced, together with paving blocks and crushed stone. The quarry could be opened much more extensively and a large quantity of high-grade material could be obtained easily.

The Winston quarry is on the north bank of James River near the James River branch of the Chesapeake & Ohio Railway, about 4 miles west of Richmond. It is in a bluff with a working face about 100 feet high opened over an area of about 1 acre. The common horizontal jointing is a prominent feature together with steep dipping joints, which trend N. 5° W. and N. 30°–70° E. The granite is sheeted with sheets thickest at the bottom and thinnest at the top. This quarry is capable of furnishing dimension stone in large amount, but has been worked mainly to supply crushed stone and rough blocks. Several other quarries have been worked along the same bluff above and below the Winston openings and all present the same features.

SHIPPING.

There are excellent facilities for shipping in most parts of the Richmond granite area, for it is traversed by several railroads. The only quarry on tidewater is the abandoned one on the west bank

of the James River at the mouth of Goode Creek, but it is only a short haul from other quarries to barges and other means of water transportation to all parts of the east coast of the United States. Above the old Manchester bridge the James River is not navigable, but the canal follows the foot of the granite bluffs on the north side of the stream. The quarries near Granite and on the south bank of James River have their outlet by the Southern Railway; the McGowan quarry is on a spur of the Seaboard Air Line Railway, and the Richmond Granite Co.'s quarries are on a spur of the Richmond, Fredericksburg & Potomac Railroad. The expense of getting the stone to market is relatively small as compared with the cost of preparing it in the quarry and shop. As the demand for stone increases, new quarries could be opened at many points along both banks of James River and also in the Brook Run and other smaller valleys which traverse the granite area. These could easily be reached by spurs from the various railroads.

Nearly all of the granite is workable, although some portions of it are of better quality than others, and the items of stripping, drainage, and jointing are factors of greater or less importance. The principal need is to create an increased demand by securing contracts which now go to other granite markets. A necessary condition also is to manage the quarry so as to fulfill contracts rapidly and with stone of satisfactory character as to color and finish.

BRICK CLAY.

There are extensive deposits of loamy clays constituting portions of the Columbia group and the Lafayette formation in the Richmond region, and the clays of the Calvert formation may prove to be suitable for brick making. There are many brickyards utilizing the clays of the Columbia group and in two places the loams of the Lafayette are used. Most of the brick produced are not of especially high grade. They are used locally and scarcely supply the present active demand. Some of the yards use primitive methods of treatment and burning, and with more modern methods the product could be materially improved. The largest plant is that of the Fuller Brick Co., on the Chesapeake & Ohio Railway 4 miles southeast of the city, where high-class methods are employed.

The clay used in the Richmond region is more or less mottled, gritty, yellow or reddish, some of it sandy and much of it contains streaks of pebbles and large bowlders, which differ in amount in adjoining yards. The clay differs in quality, even in the space of a single working face, and a combination of the varieties has been found to produce the best results. The depth of the clay varies from 6 to 18 feet, and in most areas the clay is underlain by a bed of sand.

A detailed investigation of the brick clay of Virginia has been made by Heinrich Ries [1] for the Geological Survey of Virginia, and most of the following data are taken from his report.

COLUMBIA GROUP.

Manchester.—Four yards are in operation in Manchester, just across the river from Richmond. They are all in the vicinity of Knight and Maury streets. These yards manufacture soft-mud brick, but they also produce a small amount of pressed brick. The clay used is more or less mottled, gritty, yellow or reddish, and is covered by a thin layer of sandy soil and commonly underlain by a bed of sand. In the yard of Green & Harrison the underlying granite is reached. The clays in general are very tough and plastic, but portions are sandy, and some contain a variable quantity of stony material which ranges in size from small pebbles to large bowlders, most of these being of crystalline character. This stony material is not uniformly distributed through all the clay, but lies in streaks, the greatest quantity occurring in the yards of W. J. Ready and Green & Harrison.

The yards of W. J. Ready, G. E. Redford, and W. B. Davis adjoin. Ready's has the deepest pit, and it also lies at a slightly lower level, for the upper surface of the clay is uneven and slopes toward the river. The thickness of the clay is said to be 18 feet and over. The clay is somewhat similar to that found in the neighboring yards, but it varies rather markedly in character, containing more stones and bowlders. Three different kinds are recognized in a working face about 200 feet long; of these only one, that from the northwest corner of the bank, can be used alone with good results. The clay from the west side of the bank is too tough and would crack on drying or burning, so it is tempered by admixture with the very sandy clay in the southeast corner of the bank. Analyses and tests of these clays are given below.

In Redford's yard the clay is from 12 to 17 feet thick, but the working face has a height of only 6 to 8 feet. It is a mottled gritty clay with mica fragments and many limonite stains scattered through it, and it contains also many decomposed pebbles of crystalline rock. The material is red burning. The pit is a large shallow excavation, and the run of the bank is used. for the clay, like that in Ready's yard, varies in physical character and unless mixed yields imperfect products. The bricks are molded by hand, dried in open yards, and burned in updraft kilns with permanent side walls. The fuel is wood or coal.

Davis's yard, on Fourteenth Street just south of Maury, contains a large shallow pit, with a working face 8 to 12 feet high. (See Pls.

[1] Preliminary report on a part of the clays of Virginia: Bull. Virginia Geol. Survey, No. 2.

VIII, *B*, and IX, *A*.) The clay is like that used in Redford's yard, but contains fewer stones. From the evidence of a 16-foot well in the yard it is believed that the clay is 20 to 25 feet thick and underlain by whitish sand. The brick, which are of the soft-mud variety, are made in a Hercules machine, dried in open yards, and burned in updraft kilns with permanent side walls. The fuel is wood and coal. The capacity is about 50,000 a day.

The Green & Harrison yard is just east of Ready's. It has a small pit, and a portion of the clay contains many bowlders. In its northwest corner the granite has been reached.

Rocketts.—The Fulton Brick Co. operates a yard for common brick west of the Chesapeake & Ohio Railway roundhouse. It is commonly spoken of as the Westford yard. The clay is removed to a depth of about 10 feet. Portions of it contain many cobblestones. It is underlain by a fine sand, at least 8 feet thick, which is used for sanding the brick molds. The clay is tempered in ring pits, molded by hand, and burned in Dutch kilns.

Two yards are operated by the Baltimore Brick Co. at Rocketts, near the intersection of Ohio and Williamsburg avenues. The clay is tempered in ring pits, molded by hand, and burned in Dutch kilns. It is dug from pits in the vicinity of the yard and averages from 15 to 18 feet in thickness, being underlain by sand. The clay is similar to that in the yards at Manchester, but lacks the stones and bowlders. In the southern yard the clay is molded by hand and burned in Dutch kilns. The product has a good ring, but is not very smooth or bright in color.

Southeast of this yard is one operated by Maynard & Powers. It is stated that the clay runs 20 feet in depth and is underlain by a bluish-gray sand. The working face is about 12 feet high and shows a sandy, mottled, yellowish-brown, and gritty clay similar to that occuring in the other pits in the vicinity. A sample (No. 1300) representing run of the bank was analyzed and tested, with results given below. The clay is tempered in ring pits, molded by hand, dried in open yards, and burned in Dutch kilns. A dry-pressed bricklet burned to cone 1 had a fire shrinkage of 4 per cent and burned to a light-red color. The clay is classed as a common brick clay which burned steel-hard and had an excellent color at cone 05. It gives a rather rich red at cone 1, but at cone 3 the color is too deep to be attractive.

LAFAYETTE FORMATION.

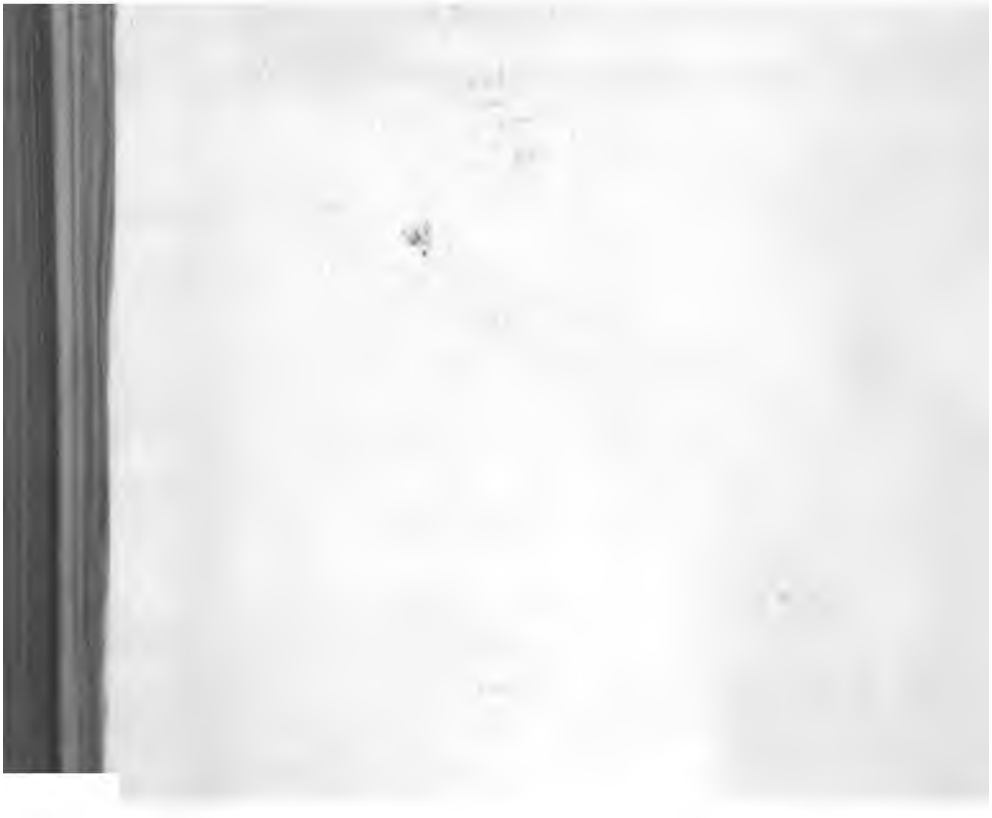
Fort Lee.—A group of yards is located at Fort Lee on the Chesapeake & Ohio Railway, about 4½ miles southeast of Richmond. The general run of clays is like those used nearer Richmond, but the stony material is lacking.

A. MAIN WORKING FACE OF DAVIS BRICKYARDS ON MAURY STREET, MANCHESTER, VA. SHOWING COLUMBIA FORMATION.

B. TYPICAL FACE OF BRICK CLAY AT ROCKETTS, RICHMOND, VA. SHOWING COLUMBIA FORMATION.

A. LAFAYETTE FORMATION IN BRICKYARD OF FULLER CO., NEAR FORT LEE, 5 MILES SOUTHEAST OF RICHMOND, VA.

B. WORKING FACE OF LAFAYETTE FORMATION IN WEST END BRICKYARDS, NEAR CAREY STREET ROAD, RICHMOND, VA.



The C. H. Oliver yard is located 1 mile west of Fort Lee. The clay here lies at the surface and the bank shows 12 feet of it, although the total thickness is said to be 20 feet. A bed of gravel and sand of unknown thickness underlies it. For making bricks the run of the bank is used. The clay is mottled in character, the mottling consisting of yellow and bluish-white clay, the latter being tougher than the former, and unless the material is thoroughly pugged before molding the bluish-white clay shows up in the product in the form of light-colored lumps. Analyses and fire tests of the clay from this bank are given in the table below. The clay may be classed as a common-brick clay, which burns to an excellent light-red color up to cone 03, rich red at cone 1, and vitrifies not far from cone 5. At cone 8 it begins to swell, owing to the fact that portions of it fuse. These fused parts are evidently small specks of iron oxide which are scattered through the clay. Care has to be taken to pug the clay thoroughly or the lumps will cause trouble in drying and burning. The clay is put through rolls and then through a soft-mud machine. The bricks are dried on pallets and burned in Dutch kilns.

Adjoining this yard on the west is that of J. M. Davis where the clay is similar. It is molded by hand, dried in kilns and on pallets, and burned in Dutch kilns. A few hundred feet up the track on the north side are two yards operated by the Fuller Brick Co. (See Pl. X, *A*.) The material is practically the same as that in the Davis yard. Here the clay is loaded on tramcars and hoisted into the plant. It passes first through rolls and then into a Freese side-cut auger machine. The clay does not appear to be difficult to work, but still the lumps of bluish gray clay are not throroughly broken and they show in the finished product. The material flows very smoothly through the die of the machine. It next passes to drying tunnels which are steam heated and remains from 38 to 40 hours. The burning is in Dutch kilns. It is evident from the results obtained that the clay will not stand rapid drying in the steam tunnels, for there are many cracked bricks. In the burning also it was noted that in several of the kilns the two rows coming above the arch were nearly vitrified, while the others were by no means so.

Ries calls attention to the fact that the clays of the Fort Lee area are less stony and less sandy than most of the others now worked about Richmond, and they could be manipulated to advantage by more improved methods. They are somewhat too siliceous for any other use than brickmaking, although probably draintile and hollow brick could be made from them, especially if purer clays are mixed in.

West End.—West of the reservoir in the city of Richmond is the West End yard. It is an extensive excavation in the Lafayette formation, which here consists mainly of loam. In places the loam is 20 feet thick, but portions of it contain considerable sand streaked with gravel. Part of the working face is shown in Plate X, *B*.

CALVERT FORMATION.

The clays of the Calvert formation underlie all of the high ground in the central part of Richmond and to the south, but as yet they have been utilized at only one yard, that of Cheatwood & Blunt. They are largely covered by the Lafayette formation, but at many points they could be excavated at moderate expense. Some of these clays are very pure and run low in silica, but others are more sandy and some consist of alternations of clay and sand which could be mixed together.

At the Cheatwood & Blunt brickyard, east of Brook turnpike north of Bacons Quarter Branch, clay of the Calvert formation is used. It is mixed with 15 to 20 per cent of sand from the upper part of the Lafayette formation. The clay contains fine sand and diatoms and apparently also a large proportion of silicate of alumina. When used pure it shrinks greatly on burning, one test brick 9½ inches long shrinking to 7½ inches. The mixing with sand is done by hand and is not very thorough, but the finished product is a compact brick of good color and great hardness. The capacity of the yard is about 28,000 a day.

Ries examined an outcrop of the clay belonging to the Calvert formation on the Williamsburg Road leading to Stagg's mill about half a mile west of the point where the road crosses the railroad. It is exposed on a sloping hillside and in such position that a large quantity can be removed without having to strip off much overburden. It is also well located for shipment. As far as can be foretold the bed is not less than 20 feet thick. It is a grayish clay which slacks slowly and works with 27.8 per cent of water to a mass of high plasticity. Its air shrinkage, 12.6 per cent, is somewhat high; as is also its average tensile strength of 300.9 pounds to the square inch. This clay is more plastic, denser burning, and less sandy than any of the clays now being worked in the Richmond area. Tempered with sand it could be utilized for brick making.

ANALYSES AND FIRE TESTS.

Analyses and results of fire tests by Ries of this and other clays are given in the following tables:

Analyses of brick clays from Richmond, Va.

	No. 1321.	No. 1325.	No. 1326.	No. 1300.	No. 1302.	No. 1330
Silica (SiO_2)	73.38	69.43	72.61	71.50	69.55	63.06
Alumina (Al_2O_3)	13.53	14.79	13.08	13.86	15.79	20.90
Iron oxide (Fe_2O_3)	5.53	6.70	5.61	7.48	6.05	6.29
Lime (CaO)	.58	.57	.96	.56	Trace.	.16
Magnesia (MgO)	.14	.63	.23	.11	.08	.45
Potash (K_2O)	2.32	2.26	2.45	2.29	1.54	3.13
Soda (Na_2O)	.47	.71	.44	.81	.38	.68
Titanic oxide (TiO_2)			.44	1.43	1.06	.04
Loss on ignition	4.03	4.85	3.65	4.61	5.52	5.29
Total	99.98	99.94	99.96	99.96	99.97	99.97
Total fluxes	9.04	10.87	10.18	8.55	8.65	10.68

Nos. 1324 to 1326 are from W. J. Ready's pit in Manchester. The first can be used alone, but the other two have to be mixed. No. 1324 is from the northwest corner of the bank. It burns to a good red color up to cone 03, but above that it becomes unsightly and at cone 5 it is very close to melting. No. 1325 is from the west side of the bank and is too tough to be used alone. When wet it is very plastic, but also gritty. It does not burn to a very dense body and has a comparatively low fire shrinkage. It becomes steel-hard at cone 1 and at cone 8 is very close to melting. No. 1326, from the southwest corner of the bank, is very sandy and has a low fire shrinkage.

No. 1300 is from Maynard & Power's pit in Rocketts.

No. 1302 is from the yard of C. H. Oliver, 1 mile west of Fort Lee. A dry-pressed bricklet burned at cone 1 showed a light-red color and a shrinkage of 4 per cent.

No. 1330 is on the Williamsburg Road leading to Stagg's mill about one-half mile west of the point where the road crosses the railroad. It becomes steel hard at cone 05. It has a light-red color up to cone 03, but at cone 1 gives an excellent dark-red color. Vitrification is reached at about cone 3 and at cone 5 it was well past vitrification, having swelled considerably.

Fire tests of brick clays from Richmond, Va., region.

WET MOLDED BRICKLETS.

	No. 1324.	No. 1325.	No. 1326.
Color	Yellow buff	Brown	Brown buff.
Water required	20.3 per cent	20.3 per cent	18.7 per cent.
Slaking	Moderately fast	Moderately fast	Fast.
Plasticity	Good	Good	Fair.
Grit	Sandy	Sandy	Sandy.
Air shrinkage	7 per cent	6 per cent	6 per cent.
Average tensile strength	93.7	132	99.
CONE 010.			
Fire shrinkage	Swelled slightly	Swelled slightly	Swelled slightly
Color	Light red	Light red	Light red.
Absorption	15.5	17.5	16.4.
CONE 05.			
Fire shrinkage	1.3	2	0.6.
Color	Red	Light red	Red.
Absorption	12.9	16.8	15.1.
CONE 03.			
Fire shrinkage	1.6	2.6	1.
Color	Red	Moderately red	Red.
Absorption	11.4	12.1	14.4.
CONE 1.			
Fire shrinkage	3.7	3.6	2.
Color	Dark red	Dark red	Red.
Absorption	6.2	9.8	10.3.
CONE 3.			
Fire shrinkage	5.3	4	3.
Color	Dark red	Dark red	Dark red.
Absorption	3.4	8.7	8.2.
CONE 5.			
Fire shrinkage	5	5	5.6.
Color	Dark red	Dark red	Red.
Absorption	1.4	6.3	1.6.
CONE 8.			
Fire shrinkage	5.5	Vitrification begins	6.
Color	Dark red	Red brown	Red brown.
Absorption	0.2	1.5	1.

Fire tests of brick clays from Richmond, Va., region—Continued.

	No. 1300.	No. 1302.	No. 1330.
Color	Yellow buff	Yellow buff	Grayish.
Water required	20.9 per cent	24.2 per cent	27.8 per cent.
Slaking	Moderately fast	Moderately fast	Slowly.
Plasticity	Good	Good	Good.
Grit	Fine	Much fine	None.
Air shrinkage	6.4 per cent	8.6 per cent	12.6 per cent.
Average tensile strength	89.6	60.6	301.
CONE 010.			
Fire shrinkage	0	0	1.
Color	Light red	Light red	Pink.
Absorption	17.4	20.2	14.4
CONE 05.			
Fire shrinkage	1.6	1.6	3.
Color	Light red	Light red	Pink.
Absorption	15.1	17.6	8.9.
CONE 03.			
Fire shrinkage	1.6	4	5.
Color	Light red	Light red	Light red.
Absorption	14.1	14.1	5.7.
CONE 1.			
Fire shrinkage	5	6.3	7.6.
Color	Red	Light red	Red.
Absorption	7.1	7.5	1.1.
CONE 3.			
Fire shrinkage	6.3	7	7.6.
Color	Dark red	Light red	Dark red.
Absorption	4	5.9	0.1.
CONE 5.			
Fire shrinkage	6.6	8.3	2.
Color	Gray brown	Dark red	Gray.
Absorption	1.4	2.6	2.4.
CONE 8.			
Fire shrinkage	6.3	7.3	0.3.
Color	Red brown	Brown	Drab.
Absorption	1.3	1.1	1.6.

Representative samples of brick clays from Rocketts and from West End Yards were collected by the writer and sent to the chemical laboratory of the United States Geological Survey at Pittsburg, Pa., for analyses. In drawing these samples a large amount of material was taken from various parts of the banks and quartered down. The following analyses and tests were made by A. V. Bleininger:

Analyses of brick clays from Richmond, Va.

	A	B
Silica (SiO_2)	73.39	70.91
Alumina (Al_2O_3)	14.07	15.91
Ferric oxide (Fe_2O_3)	4.31	3.15
Titanium oxide (TiO_2)	1.02	1.01
Lime (CaO)	.09	.15
Magnesia (MgO)	.35	.66
Soda (Na_2O)	.16	.47
Potash (K_2O)	.42	1.24
Water at 100° C	1.32	1.85
Ignition loss	4.91	4.75

A. From Lafayette formation in yards of West End Brick Co.
B. From Rocketts Yards.

The material of analysis A is a reddish clay, very high in sand, and is so deficient in plasticity that it can not be worked by the stiff-mud process, but only by hand molding or in the soft-mud machine. Its drying shrinkage, however, is 7.4 per cent in terms of the dry length and the burning shrinkage 2.2 per cent at 1,150° C. The clay stands up well in the fire and is not easily overburnt. It can not, however, be made to produce vitrified products without serious kiln loss. The color is a good clean red.

The other sample (analysis B) is a soft, buff-colored clay, possessing good working plasticity, which would make it suitable for the manufacture of stiff-mud brick, tiles, etc. Its texture is very much finer than that of sample A. It does not check or warp in drying. The drying shrinkage is 6.8 per cent in terms of the dry length. The burning shrinkage is 1.3 per cent at 1,150° C. and 5.8 per cent at 1,250°. The clay has a long vitrification range, and hence is a safe material to burn, resulting in low kiln loss. The color is an excellent clean red.

The material of analysis B is greatly to be preferred to that of analysis A in every respect as far as working quality, drying, and burning behavior are concerned, and in addition the strength of the former when burnt is decidedly greater than that of the latter, which, unless burnt to about 1,150° C., is inferior in this respect and apparently not able to withstand the effects of freezing and thawing for any considerable number of years.

MOLDING SAND.

Portions of the Aquia formation and the Columbia group consist of sand suitable for molding and they are the source of local supply. Certain peculiar features are requisite in molding sand. It must be sufficiently fine grained and coherent to take sharp impressions in the molds, resistant to heat, porous enough to permit escape of steam and gas, and free from materials which will give off gases or cause shrinkage. A small percentage of clay is necessary to make the sand coherent, but if the amount is too great it causes shrinkage, which is a most disadvantageous quality.

The largest pit is in the sand of the Aquia formation on the south side of Almond Creek, one-fourth mile above the crossing of the road that passes through the Rocketts brickyards to join the Charles City Road. The deposit is overlain by the Calvert formation and the face exposed is about 15 feet high. The sand is gray and greenish, mottled with buff blotches. Another smaller pit is on the east side of the road above mentioned, just south of the crossing of Almond Creek.

The sand underlying the brick clay in G. E. Redford's yard in the vicinity of Knight and Maury streets, Manchester, is used to a considerable extent for molding.

A number of molding sands from the Richmond region, collected by H. Ries, were analyzed at the Virginia Polytechnic Institute[1] by J. R. Eoff, jr., and J. H. Gibboney, with the following results:

Analyses of molding sands from Richmond, Va.

	No. 1.	No. 2.	No. 3.	No. 4.
Silica (SiO_2)	81.59	82.08	66.12	82.32
Alumina (Al_2O_3)	6.46	7.12	16.54	7.80
Iron oxide (Fe_2O_3)	4.94	4.63	4.46	3.98
Lime (CaO)	.14	.36	.40	.54
Magnesia (MgO)	.22	.35	.22	.41
Potash (K_2O)	1.19	1.28	2.67	1.64
Soda (Na_2O)	.59	.41	.35	.80
Titanic oxide (TiO_2)	1.90	.30	.14	.22
Water (H_2O)	1.63	1.66	4.90	.19
Water (moisture)	1.46	1.52	4.15	.14
	100.12	99.71	99.95	98.04

No. 1. Sand (Redford pit) from foundry, Manchester, Va.
No. 2. Yellow sand collected at Redford pit, Manchester, Va.
No. 3. Coarse sand, Harbaugh pit, Richmond, Va.
No. 4. Used sand, Redford pit, Manchester, Va.

The following physical tests were made by Ries.

Physical tests of molding sands from Richmond, Va.

Sample.	20 mesh.	40 mesh.	60 mesh.	80 mesh.	100 mesh.	100 mesh.[1]	Clay.
							Per cent.
No. 2	1.51	1.26	1.27	0.56	6.27	71.69	16.52
No. [illegible]	42.48	12.90	6.16	.85	1.70	8.58	26.44
No. [illegible]	5.34	14.73	10.41	1.28	14.01	59.37	3.52

[1] Passed through 100-mesh sieve.

DIATOMACEOUS EARTH.

The diatom deposits forming part of the Calvert formation about Richmond have so far not been utilized. The deposits are irregular in form and the amount of high-grade material available is not as large as at some other localities in Virginia and Maryland. The purer deposits are soft claylike material, which when dry is of very porous texture, of white color or slightly yellowish tint, and exceedingly light weight. It is mostly fine silica and consists of the minute frustules of plants known as diatoms. The chief use for diatomaceous earth is for cleaning and polishing, either in the form of powder or mixed with soap. It is an effective nonconductor of heat and has been used alone or with various compounds for coverings for boilers, steam pipes, and safes, and in fireproof cements. Its great absorbent qualities fit it admirably for use in water filters and for dynamite. For the latter use it is mixed with wood pulp. It is used largely by paint manufacturers as a wood filler. Boiled with shellac

[1] Mineral resources of Virginia, pp. 394–395.

it is made into records for talking machines. In Germany it has been used for absorption of liquid manures so that they could be utilized as fertilizers, as a source of silica in making water glass, in the manufacture of cement, tile glazing, artificial stone, ultramarine and other pigments of aniline and alizarine colors, paper filling, sealing wax, fireworks, hard-rubber objects, matches, papier-mâché, for solidifying bromine, and for many other purposes. In preparing the earth for market it is first roasted in large rooms in order to expel much of the water and organic matter. It is then transferred to a furnace and heated to a moderately high temperature, but with care not to destroy the porosity by overheating. It is then ground fine between rollers, sieved, and promptly sacked to prevent reabsorption of moisture. For some uses it is only necessary to give a prolonged drying in a chamber heated by steam pipes prior to grinding and sieving. The value runs from $6 to $9 a ton. California, Illinois, Maryland, Massachusetts, Missouri, and New York are the principal sources in this country, and about 3,000 tons a year are imported.

Two samples of the diatom deposit in the Calvert formation in Richmond have been tested by Ries as to their suitability for brick or other wares. They were collected from Seventh Street near the locomotive works. One sample (A) was weathered material, the other was from a point deeper in the bank. Analyses are given on page 26, which indicate that in the material of sample A 8.73 per cent of fluxes are contained and 31.6 per cent of water was required. Some grit was found and the air shrinkage was 13. In sample B there are 10.21 per cent of fluxes, 34.6 per cent of water was required, and air shrinkage was 14.

The fire tests give the following results:

Fire tests of diatom deposits from Richmond, Va.

	1,720° F., cone 010.	1,922° F., cone 05.	1,994° F., cone 03.	2,102° F., cone 1.	2,174° F., cone 3.	2,240° F., cone 5.	2,354° F., cone 8.
Sample A:							
Fire shrinkage	0.6	0.6	2.0	3.0	3.3	5.0	2.0
Color	Light red.	Light red.	Light red.	Light brown.	Red brown.	Red gray.	Brown.
Absorption	14.6	13.6	12.4	9.1	6.9	5.0	2.0
Sample B:							
Fire shrinkage	6.0	2.3	3.3	5.0	6.0	6.0	5.5
Color	Light red.	Light red.	Light red.	Medium red.	Medium red.	Red gray.	Red gray.
Absorption	14.9	10.9	9.0	4.2	2.3	1.7	1.1

A sample of much finer material from Maryland, when tested with cone 27 (temperature 3,038° F.), fused into a brownish glass, which demonstrates that it is not refractory at high temperature.

The higher silica content in sample A appears to affect its porosity and shrinkage in burning.

OCHER.

For many years yellow ocher of fine quality was produced near Bermuda Hundred, 15 miles southeast of Richmond. The mine was on the north branch of Appomattox River just below the mouth of Ashton Creek, 4 miles southeast of Bermuda Hundred. The first extensive operations were in 1872, when the material was placed on the market as "Bermuda ocher" at 2½ cents a pound in competition with imported ocher selling at 3¾ cents a pound. Its superior quality was at once recognized, and for many years it found a ready market, although the price dropped to an average of $22 a ton. In 1880 the production was 1,000 tons, produced by 30 workmen. The crude ocher was washed, dried, and ground, and three grades were produced, "single washed," "double washed," and "extra floated." The values were, respectively, $18, $21, and $27 per ton. Production of of this material continued for about 30 years, when apparently the deposit gave out. The place is now abandoned and the workings are caved in.

The ocher is a yellow earthy mineral consisting of sesquioxide of iron in hydrous form mixed with a small amount of clay. In observations made 15 years ago the writer found that it occurred in a bed 3 to 5 feet thick, of which the upper 2 feet or more was the purest. It is a member of the Patuxent formation, and at the mines was overlain by about 30 feet of typical arkosic gravelly sand of that formation capped by gravels of Lafayette formation. Below the ocher is green sandy clay grading into 80 feet of gray sand.

The ocher was exposed for about 800 feet along the slope of the bluff. Its western termination was not visible, but to the east it was seen to thin rapidly and to disappear a few rods east of the pits. Here the green sandy clay and sand thicken to 10 or 14 feet and are underlain by typical arkosic sands filled with pebbles and bowlders extending down to the water. It is believed that the ocher was deposited as a bog iron ore in some pool of restricted area.

This occurrence of ocher in the Patuxent formation is a most exceptional feature, for no deposits of the material have been found in it elsewhere. It is possible, however, that they may occur, and the material should be carefully looked for in new cuts and wells throughout the area of the formation. A deposit similar to the one west of Bermuda Hundred would be of considerable value.

CONCRETE MATERIALS.

An abundant supply of crushed granite and coarse river sand is available for concrete in Richmond. One large quarry, on Belle Island in James River, is worked by the Old Dominion Iron & Nail Works to supply crushed granite, which is sold in Richmond for $1.60

to $1.80 a ton delivered. A sample (No. 9) of this material was sent to the laboratory in Pittsburg to be tested.

Gravel is dug at several pits within the city limits and brings at present from $1 to $1.25 a yard delivered. It is a quartz and quartzite mixture, consisting mainly of very hard material. One pit on Gillis Creek screens gravel from the Patuxent formation. Others in the northern part of the city on Cannon Creek screen the Lafayette formation, which here consists largely of gravel. Nearly all the contractors in Richmond have a strong preference for the crushed granite.

Sand for concrete is pumped from James River through washers and screens. One of the principal producers is Stephen A. Ellison & Co., at Seventeenth and Dock streets. A sample (No. 8) of this sand was sent to the Pittsburg laboratories. The sand is sold for 50 cents a yard on the bank of the river. An examination of this sand made September 23, 1908, by Froehling & Robertson, chemists, of Richmond, showed the following sizes of grains:

	Per cent.
$\frac{1}{4}$ to $\frac{1}{10}$ inch	7.1
$\frac{1}{10}$ to $\frac{1}{20}$ inch	16.5
$\frac{1}{20}$ to $\frac{1}{30}$ inch	15.5
$\frac{1}{30}$ to $\frac{1}{40}$ inch	27.1
$\frac{1}{40}$ to $\frac{1}{50}$ inch	19.4
$\frac{1}{50}$ to $\frac{1}{60}$ inch	3.0
$\frac{1}{60}$ to $\frac{1}{80}$ inch	10.2
$\frac{1}{80}$ to $\frac{1}{100}$ inch	1.0
Finer than $\frac{1}{100}$ inch	.2
	100.00

These proportions are highly advantageous and briquet tests made with high-grade Portland cement showed very high strength. The grains are nearly all quartz, and sharp. The freedom from silt is due to the vigorous washing which the sand receives when it is pumped into the scows.

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